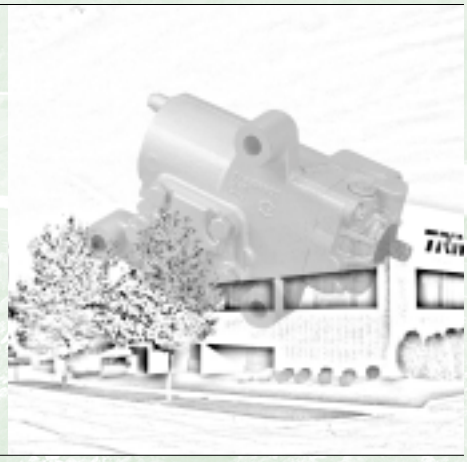
TRW Automotive

Commercial Steering Systems

TAS Steering Gear Service Manual

TAS40,55,65, AND 85 SERIES



Hazard Warning Definitions

⚠ **WARNING**	**A warning describes hazards or unsafe practices which could result in severe personal injury or death.**
⚠ **CAUTION**	**A caution describes hazards or unsafe practices which could result in personal injury or product or property damage.**
NOTE	A note gives key information to make following a procedure easier or quicker.

Disclaimer

This Service Manual has been prepared by TRW Commercial Steering Systems for reference and use by mechanics who have been trained to repair and service steering components and systems on heavy commercial vehicles. TRW Commercial Steering Systems has exercised reasonable care and diligence to present accurate, clear and complete information and instructions regarding the TRW Commercial Steering TAS Series Integral Power Steering Gears. Since this is a general Service Manual, the photographs and illustrations may not look exactly like the steering gear being serviced. The procedures, therefore , must be carefully read and understood before servicing.

If inspection or testing reveals evidence of abnormal wear or damage to the TAS steering gear or if you encounter circumstances not covered in the Manual, **Stop - Consult the vehicle manufacturer's Service Manual and warranty. Do not try to repair or service a TAS steering gear which has been damaged or includes any part that shows excessive wear unless the damaged and worn parts are replaced with original TRW replacement and service parts and the unit is restored to TRW's specifications for the TAS steering gear.**

It is the responsibility of the mechanic performing the maintenance, repairs or service on a particular TAS steering gear to (a) inspect the steering gear for abnormal wear and damage, (b) choose a repair procedure which will not endanger his/her safety, the safety of others, the vehicle, or the safe operation of the vehicle, and (c) fully inspect and test the TAS steering gear and the vehicle steering system to ensure that the repair or service of the steering gear has been properly performed and that the steering gear and system will function properly.

Patents

TRW Commercial Steering Division TAS power steering gears are covered by several United States and foreign patents, either issued or pending.

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⚠ WARNING **All steering mechanisms are safety critical items. As such, it is imperative that the instructions in this booklet be followed to the letter. Failure to observe the procedures set forth in this pamphlet may result in a loss of steering.**

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Introduction

This new TAS Service Manual replaces all previous editions of TRW's TAS40, 55, 65 and 85 Service Manuals.

Changes in the layout of this Service Manual reflect TRW's commitment to provide easily usable material and highly recognizable hazard notices. Some of the major changes are:

- Revised torque, force, pressure and flow notations that conform to international standards.
- Service Manual divided into sections for easier reference.
- Uninterrupted resealing instructions. Reference to damage section allows you to repair or replace damaged parts and return to the resealing procedures easily.
- Binding process that better allows the Service Manual to lay flat.

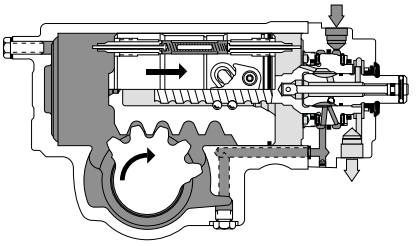
The three-column format used in the Service Manual will also help make it easy for you to service a steering gear. Column 1 illustrates the procedure with photographs, column 2 gives a brief key as well as tools to be used for each procedure, and column 3 explains in detail the procedure you should follow. **Pay special attention to the notes, cautions and warnings.**

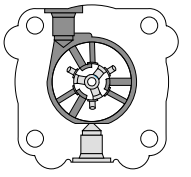
Item numbers on the exploded view correspond with item numbers used throughout the Service Manual.

As you gain experience in servicing TAS steering gears, you may find that some information in this Service Manual could be clearer and more complete. If so, let us know about it. Don't try to second-guess the Service Manual; if you do not understand a procedure, or are stuck, contact our Field Service Department at 765.423.5377. Servicing TAS series steering gears should be safe and productive.

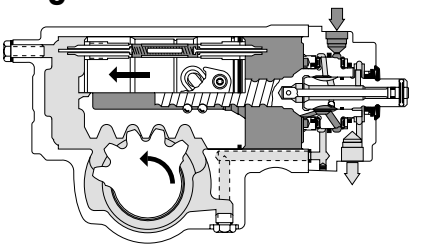
Oil Flow Illustration

Left Hand Lead



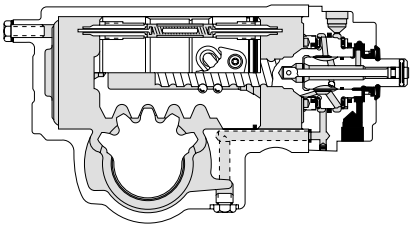


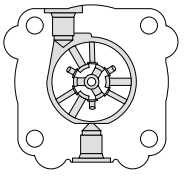
Right Hand Lead

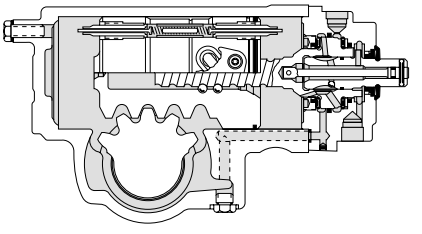


Right Hand Turn

Steering Wheel Input:
Clockwise Rotation

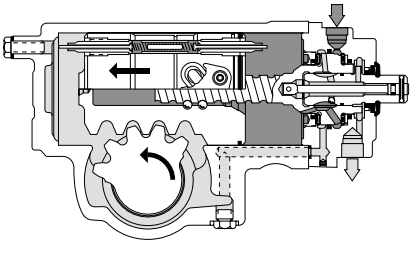


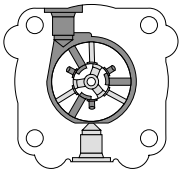


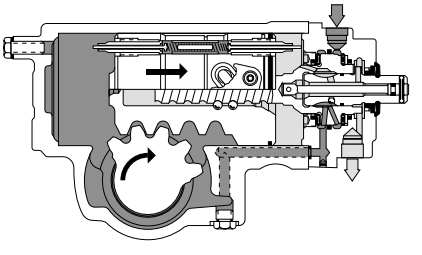


Straightline Running

No Steering Action







Left Hand Turn

Steering Wheel Input:
Counter-Clockwise Rotation

Supply Pressure

Return Pressure

General Design

Integral Power Steering

TAS power steering gears are the latest design in the TRW Commercial Steering Division family of integral hydraulic power steering gears. Integral hydraulic power steering means that the gear contains a manual steering mechanism, a hydraulic control valve, and a hydraulic power cylinder, all in a single, compact package.

Rotary Control Valve

The rotary control valve combines simplicity of construction with desirable performance characteristics. The speed at which the driver can turn the steering wheel with power assist is dependent upon the pump flow (measured in gallons per minute or liters per minute) directed to a cylinder cavity. The control valve controls flow through the steering gear.

The pressure (measured in pounds per square inch, or bar) required for the gear to steer the vehicle is created by the power steering pump to overcome resistance at the steered wheels. The control valve senses these requirements and directs fluid to the appropriate cylinder cavity in the steering gear (and in the auxiliary cylinder if it is a dual steering system) at the proper flow rate and pressure.

Pressure Means Work, Flow Means Speed

The higher pressure a steering gear can withstand, the more work it can perform. The maximum operating pressure for all TAS gears is 2,175 psi (150 bar), maximum flow rate for all TAS gears is 8 gal/min (30.3 L/min).

The TAS series gears can steer a vehicle within its front-end weight rating through a turn at low speed and engine idle. As the driver turns the steering wheel faster or slower, more or less fluid will be required by the gear. TAS series vehicle front-end weight ratings are as follows:

Gear	Front Axle Rating
TAS40	9,000 lb (4,100 kg)
TAS55	12,000 lb (5,400 kg)
TAS65	14,300 lb (6,500 kg)
TAS85	18,000 lb (8,200 kg)

The recommended minimum flow at 1½ steering wheel turns per second is as follows:

Gear	Minimum Flow Rate
TAS40	2.2 gal/min (8.3 L/min)
TAS55	2.6 gal/min (9.8 L/min)
TAS65	3.0 gal/min (11.4 L/min)
TAS85	3.6 gal/min (13.6 L/min)

If the steering gear valve is controlling an auxiliary cylinder, increased minimum flow is required (generally at least 75%) based on the size of the auxiliary cylinder and the vehicle's steering geometry.

Maximum internal leakage for all TAS gears is 1 gal/min.

General Operation

What Happens During a Steering Maneuver

When the driver turns the steering wheel, he transmits force from the steering wheel to the steering gear input shaft. A torsion bar, pinned at its one end to the input shaft and at its other end to the worm shaft, turns with the input shaft and exerts a rotational force on the worm shaft. In response to this rotational force, the worm shaft, acting through the recirculating ball mechanism, tries to move the rack piston axially through the gear housing cylinder bore.

The rack piston's axial movement is resisted by its engagement to the sector shaft, which is connected by linkage to the steered wheels. Because of this resistance, the torsion bar is twisted by the input shaft, thereby actuating the control valve. Pressurized fluid, directed by the control valve, assists in moving the rack piston axially through the cylinder bore. The rack piston then turns the sector shaft to steer the vehicle.

Shock Loads to the Gear

If the steered wheels receive a shock load, the shock forces are transmitted through the sector shaft to the rack piston, and on to the worm shaft. The internal geometry of the steering gear causes the control valve to send high-pressure fluid to the correct cylinder cavity to resist the shock forces. By absorbing the shock forces hydraulically, the steering gear prevents objectionable kickback at the steering wheel.

Unloading (Poppet) Valves

Most TAS gears are equipped with two unloading valves, one at each end of the rack piston. One valve or the other, depending on the direction of turn, will trip as the steered wheels approach the axle stops (which must be set according to manufacturer's specification). The tripped valve reduces pressure in the gear and helps to reduce heat generated by the pump. At the same time, the valves also reduce forces on the steering linkage. These valves are automatically set to axle stops after installation in vehicle at first full right and left turn.

Relief Valve

Some TAS gears, (with or without poppets), are supplied with a relief valve. The relief valve limits maximum supply pressure to protect the power steering gear, but it does not reduce pressure as the steered wheels approach the axle stops.

Bleed Systems

Some TAS gears which are mounted with the output shaft above the rack piston bore are equipped with either an automatic bleed system or a manual bleed screw.

The procedure for air bleeding the system is on page 17 of this manual. Replacement of damaged automatic bleed plugs, and manual bleed screws is described on page 62.

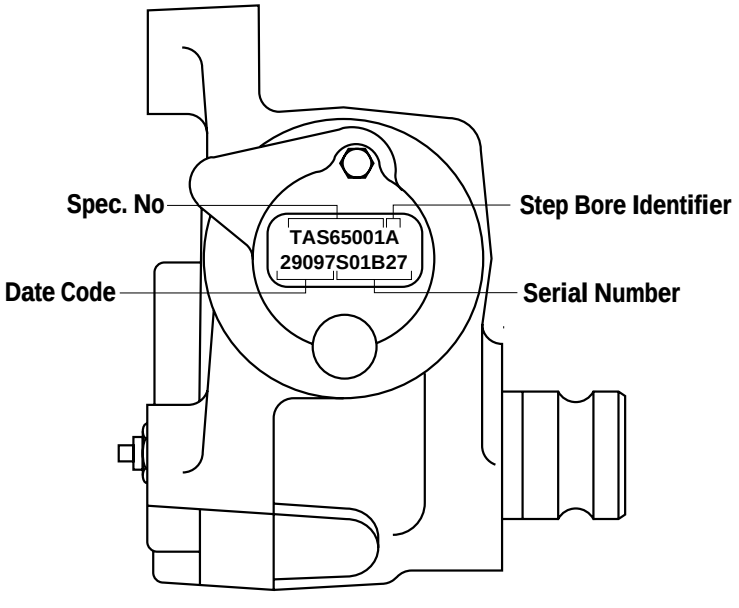
Approved Hydraulic Fluids

Fluids approved and recommended for use in TRW steering systems include:
- Automatic Transmission Fluid Dextron II, III, Mercon
- Automatic Transmission Fluid ATF +4

NOTE **Use of fluids other than approved and recommended may void the steering system warranty.**

⚠ WARNING **Completely flush the steering system with one of the recommended fluids above only. Do not mix oil types. Any mixture or any unapproved oil could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.**

Specification Numbers



The steering gear specification number and date code are stamped on a machined surface opposite the input shaft of every TAS gear. Newer gears include a serial number.

An example date code would be 29097; this means the gear was built on the 290th day of 1997.

An "A" included at the end of the specification number indicates a step bore housing.

Torque Chart

Part Name	Item #	Torque Range Dry	Torque Range Lubricated
Auxiliary cylinder plug	54	25-35 lbf•ft (34-48 N•m)	
Ball return guide cap/strap bolts	31	14-22 lbf•ft (19-29 N•m)	
Bearing adjuster	17		11-15 lbf•ft (15-20 N•m)*
Locknut	18		101-122 lbf•ft (137-165 N•m)**
Manual bleed screw	50	40-50 lbf•in. (3.1-3.7 N•m)	
Plug, auto bleed	51	38-58 lbf•ft (52-79 N•m)	
Poppet sleeve assembly	22	16-20 lbf•ft (22-27 N•m)	
Poppet sealing nut, service	60	33-37 lbf•ft (45-50 N•m)	
Poppet fixed stop screw	52	38-42 lbf•ft (52-57 N•m)	
Poppet fixed stop screw	52A	38-58 lbf•ft (52-79 N•m)	
Relief valve cap	56	25-35 lbf•ft (34-48 N•m)	
Sector shaft adjusting screw jam nut	47	40-45 lbf•ft (54-61 N•m)	
Side cover bolts (TAS40)	48		108-128 lbf•ft (147-174 N•m)
Side cover bolts (TAS55, 65, 85)	48		160-180 lbf•ft (217-244 N•m)
Valve housing bolts (TAS40, 55, 65)	1		75-85 lbf•ft (102-115 N•m)
Valve housing bolts (TAS85)	1		108-128 lbf•ft (147-174 N•m)

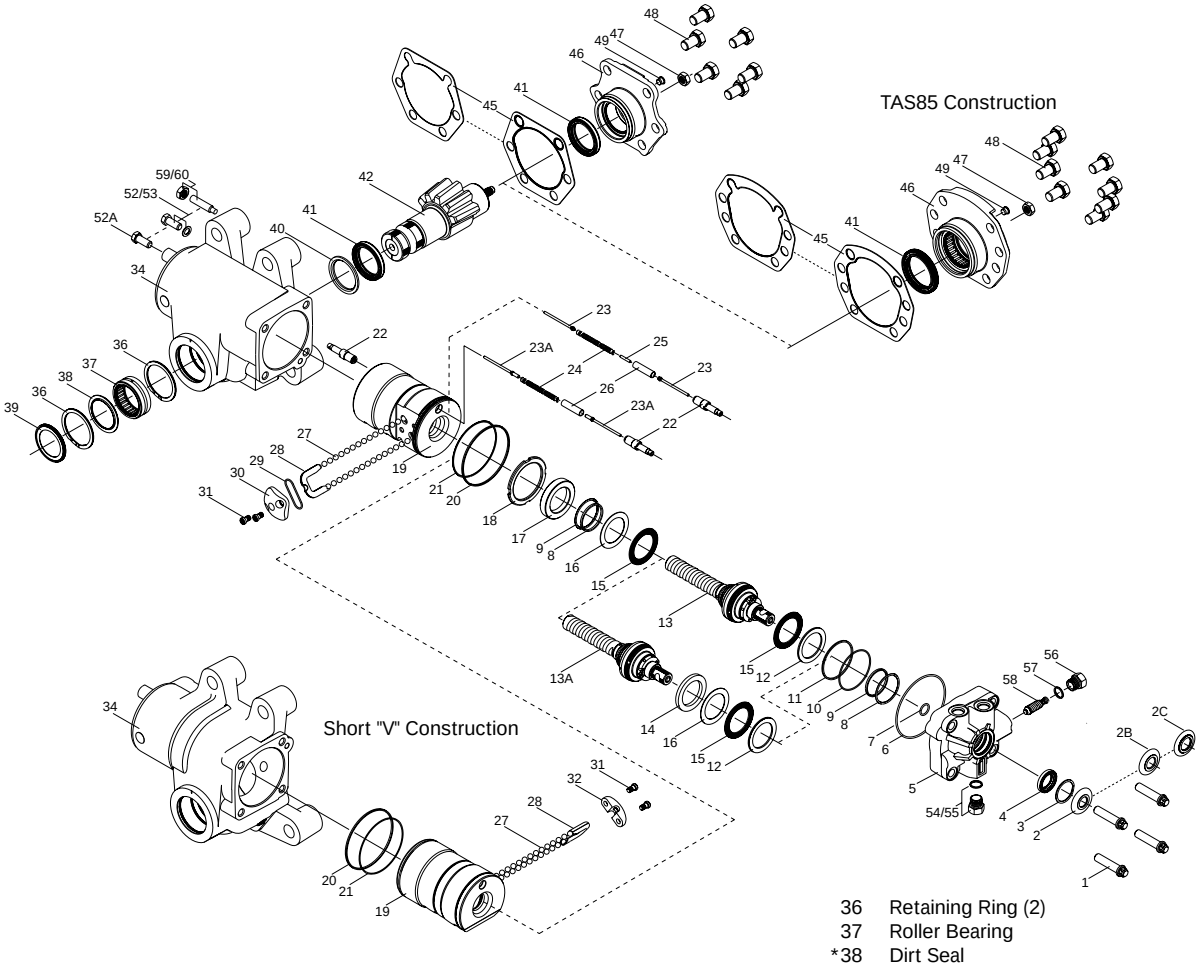
Item numbers referenced are shown on the exploded views, pages 10 and 12.

* After tightening to this torque value, the adjuster must be backed off ¼ to ½ of a turn as described in step 22 on page 57.

** Torque value indicated is using recommended tools.

Special tools can be purchased through:
SPX Corporation
Kent-Moore Tool Group
28635 Mound Road
Warren, MI 48092
1-800-328-6657

TAS Series Exploded View -- Standard



Item	Description
1	Bolts (4-Valve Housing)
*2	Dirt and Water Seal 13/16" Serr.
*2B	Dirt and Water Seal 7/8" Serr.
*2C	Dirt and Water Seal 1" Serr.
*3	Retaining Ring
*4	Seal (Input Shaft)
5	Valve Housing
*6	Seal Ring (Valve Housing)
*7	Seal Ring (Valve Housing)
*8	Seal Ring (2)
*9	O-ring (2)
*10	Seal Ring
*11	O-ring (Valve Housing)
12	Thrust Washer (Thick)
13	Input Shaft, Valve, Worm Assy.
13A	Input Sh., Valve, Worm Assy. (Alt.)
14	Spacer Sleeve (Alt.)
15	Thrust Bearing (1 or 2)
16	Thrust Washer (Thin)
17	Bearing Adjuster
*18	Adjuster Locknut
19	Rack Piston
*20	Teflon Seal Ring
*21	O-ring (Back up; Rack Piston)
22	Poppet Seat and Sleeve Assy. (2)
23	Poppet (2)
24	Poppet Spring
25	Spacer Rod
26	Push Tube
27	Balls
28	Ball Return Guide Halves (2)
*29	Seal (Cap)
30	Ball Return Guide Cap
*31	Torx Screws (2-Cap/Strap)
*32	Ball Return Guide Strap
34	Housing
35	Grease Fitting
36	Retaining Ring (2)
37	Roller Bearing
*38	Dirt Seal
*39	Dirt and Water Seal (Trunnion)
40	Washer (Spacer)
*41	Seal (2-Output)
42	Sector Shaft
43	Adjusting Screw (Sector Shaft)
44	Retainer (Adjusting Screw)
*45	Gasket (Side Cover)
46	Side Cover Assembly
47	Jam Nut
48	Special Bolts (6 or 8-Side Cover)
*49	Vent Plug (Side Cover)
50	Bleed Screw (Manual)
51	Plug (Auto Bleed)
52	Fixed Stop Screw (Poppet)
52A	Fixed Stop Screw (Poppet-Alt)
53	Washer (Stop Screw)
54	Auxiliary Port Plug (2)
*55	O-ring (2-Aux. Port Plug)
56	Relief Valve Cap
*57	O-ring (Relief Valve)
58	Relief Valve (2 piece)
59	Service Poppet Adjusting Screw
60	Service Sealing Jam Nut

*These items are included in complete seal kits along with 045422 lubricant and a service bulletin.

Service Parts List - Standard

Common Parts

Item	Description	Part Number
1	Bolts (4-Valve Housing)	020251
2	Dirt and Water Seal 13/16" Serr.	478044
2B	Dirt and Water Seal 7/8" Serr.	478060
2C	Dirt and Water Seal 1" Ser	478050
3	Retaining Ring	401637
4	Seal (Input Shaft) (High Temp)	478076
7	Seal Ring (Valve Housing)	032823
8	Seal Ring (2)	029123
9	O-ring (2) (High Temp)	032200-158
10	Seal Ring	029116
11	O-ring (Valve Housing) (High Temp)	032200-152
12	Thrust Washer (Thick)	400143
15	Thrust Bearing (2)	070027
16	Thrust Washer (Thin)	400144
17	Bearing Adjuster	400149
18	Adjuster Locknut	027007
27	Balls	213684-X1
29	Seal (Cap)	478042
30	Ball Return Guide Cap	400161
31	Torx Screws (2-Cap/Strap)	020228
32	Ball Return Guide Strap	400167
35	Grease Fitting	037032
43	Adjusting Screw (Sector Shaft)	021200
44	Retainer (Adjusting Screw)	062005
47	Jam Nut	025150
49	Vent Plug (Side Cover)	036201
50	Bleed Screw (Manual)	213705
51	Plug (Auto Bleed)	021397
52A	Fixed stop screw	021426
54	Auxiliary Port Plug (2)	415437-A1
55	O-ring (2-Aux. Port Plug)	032229
57	O-ring (Relief Valve)	032200-153
59	Service Poppet Adjusting Screw	021407
60	Service Sealing Jam Nut	025119

Parts Vary by Specification*

Item	Description
5	Valve Housing
13	Input Shaft, Valve, Worm Assy.
13A	Input Shaft, Valve, Worm Assy. (Alt.)**
14	Spacer Sleeve (Alt.)**
19	Rack Piston
34	Housing
42	Sector Shaft
46	Side Cover Assembly
56	Relief Valve Cap
58	Relief Valve (2 piece)

*Contact Service/Sales for part numbers
**Applicable to TAS65 gears only

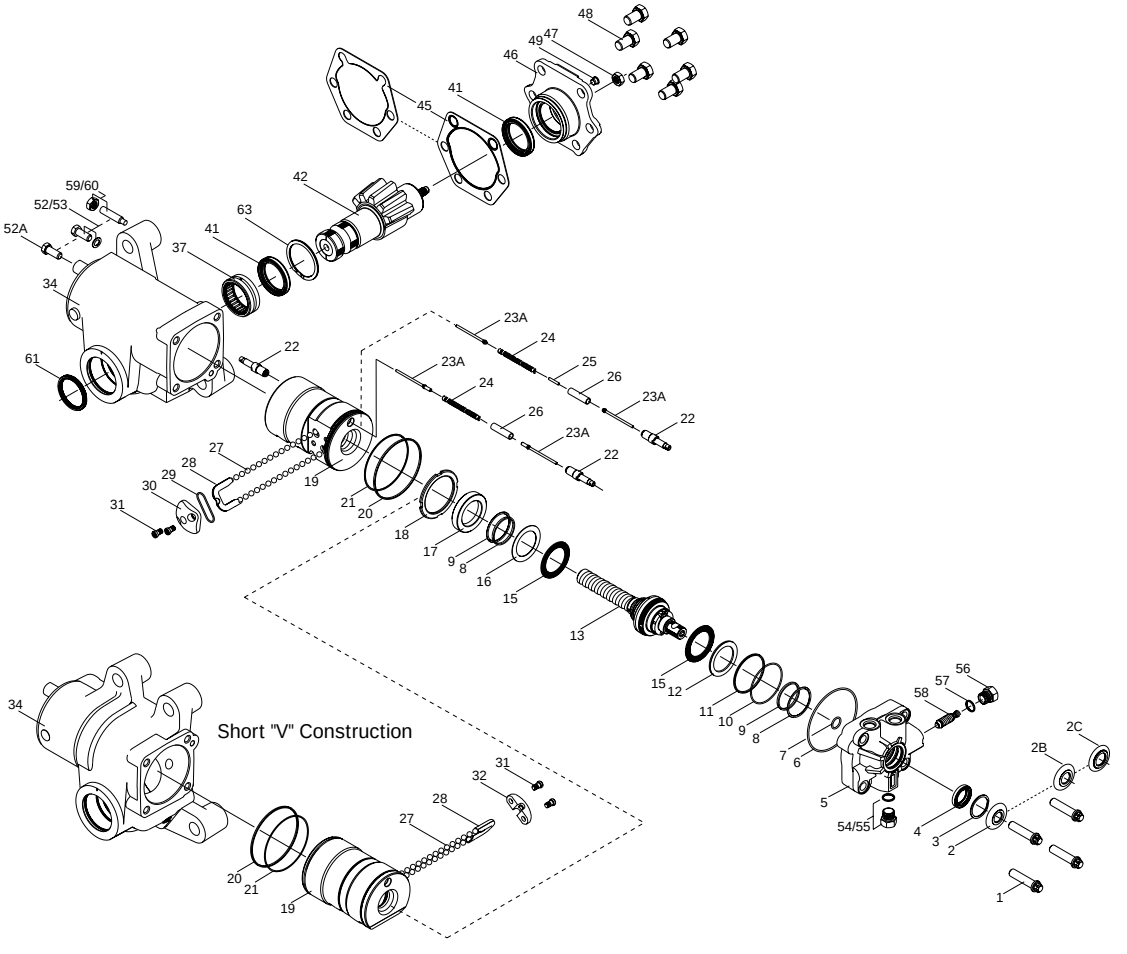
Kits

Items	Description	Part Number
54 & 55	Port Plug & O-ring	415437-A1
56 & 57	Relief Valve Cap & O-ring	411061-A1
59 & 60	Adj. Screw & Jam Nut	021407-X1
2, 2B, 2C, 3, 4	Input Shaft Seal Kit	TAS000001
	TAS40 Seal Kit	TAS400004
	TAS55 Seal Kit	TAS550004
	TAS65 Seal Kit	TAS650012
	TAS85 Seal Kit	TAS850003

Parts Vary by Gear Size

Item	Description	TAS40	TAS55	TAS65	TAS85
6	Seal Ring (Valve Housing)	032829	032829	032616	032834
20	Teflon Seal Ring	032828	032830	032590	032547
21	O-ring (Back up; Rack Piston)	032827	032831	032615	032556
22	Poppet Seat and Sleeve Assy. (2)	409118-A2	409118-A2	409118-A2	409118-A6
23	Poppet (2-old design)	040210	040210	040210	040217
23A	Poppet (2-new design)	040248	040248	040248	040249
24	Poppet Spring	401662	401662	401662	401684
25	Spacer Rod	040209	040209	040209	040218
26	Push Tube	080154	080154	080154	080158
28	Ball Return Guide Halves (2) R.H.	400158	400160	400156	400162
	L.H.	400159	400165	400157	400163
36	Retaining Ring (2)	401674	401650	401650	401685
37	Roller Bearing	070030	071032	071033	072004
38	Dirt Seal	478052	478041	478041	478057
39	Dirt and Water Seal (Trunnion)	478053	478045	478045	478059
40	Washer (Spacer)	028527	028519	028519	028534
41	Seal (2-Output)	478051	478040	478040	478084
45	Gasket (Side Cover)	HFB529000	HFB649000	HFB649000	TAS859000
48	Special Bolts (6 or 8-Side Cover)	021277	021434	021434	021434

TAS Series Exploded View -- Step Bore



Item	Description
1	Bolts (4-Valve Housing)
*2	Dirt and Water Seal 13/16" Serr.
*2B	Dirt and Water Seal 7/8" Serr.
*2C	Dirt and Water Seal 1" Serr.
*3	Retaining Ring
*4	Seal (Input Shaft)
5	Valve Housing
*6	Seal Ring (Valve Housing)
*7	Seal Ring (Valve Housing)
*8	Seal Ring (2)
*9	O-ring (2)
*10	Seal Ring
*11	O-ring (Valve Housing)
12	Thrust Washer (Thick)
13	Input Shaft, Valve, Worm Assy.
15	Thrust Bearing (1 or 2)
16	Thrust Washer (Thin)
17	Bearing Adjuster
*18	Adjuster Locknut
19	Rack Piston
*20	Teflon Seal Ring
*21	O-ring (Back up; Rack Piston)
22	Poppet Seat and Sleeve Assy. (2)
23	Poppet (2)
24	Poppet Spring
26	Push Tube
27	Balls
28	Ball Return Guide Halves (2)
*29	Seal (Cap)
30	Ball Return Guide Cap
*31	Torx Screws (2-Cap/Strap)
*32	Ball Return Guide Strap
34	Housing
35	Grease Fitting
37	Roller Bearing
*41	Seal (2-Output)
42	Sector Shaft
43	Adjusting Screw (Sector Shaft)
44	Retainer (Adjusting Screw)
*45	Gasket (Side Cover)
46	Side Cover Assembly
47	Jam Nut
48	Special Bolts (6 or 8-Side Cover)
*49	Vent Plug (Side Cover)
50	Bleed Screw (Manual)
51	Plug (Auto Bleed)
52	Fixed Stop Screw (Poppet)
52A	Fixed Stop Screw (Poppet-Alt)
53	Washer (Stop Screw)
54	Auxiliary Port Plug (2)
*55	O-ring (2-Aux. Port Plug)
56	Relief Valve Cap
*57	O-ring (Relief Valve)
58	Relief Valve (2 piece)
59	Service Poppet Adjusting Screw
60	Service Sealing Jam Nut
*61	Dirt & Water Seal (Trunnion)
63	Retaining Ring

*These items are included in complete seal kits along with 045422 lubricant and a service bulletin.

Service Parts List - Step Bore

Common Parts

Item	Description	Part Number
1	Bolts (4-Valve Housing)	020251
2	Dirt and Water Seal 13/16" Serr.	478044
2B	Dirt and Water Seal 7/8" Serr.	478060
2C	Dirt and Water Seal 1" Ser	478050
3	Retaining Ring	401637
4	Seal (Input Shaft) (High Temp)	478076
7	Seal Ring (Valve Housing)	032823
8	Seal Ring (2)	029123
9	O-ring (2) (High Temp)	032200-158
10	Seal Ring	029116
11	O-ring (Valve Housing) (High Temp)	032200-152
12	Thrust Washer (Thick)	400143
15	Thrust Bearing (2)	070027
16	Thrust Washer (Thin)	400144
17	Bearing Adjuster	400149
18	Adjuster Locknut	027007
27	Balls	213684-X1
29	Seal (Cap)	478042
30	Ball Return Guide Cap	400161
31	Torx Screws (2-Cap/Strap)	020228
32	Ball Return Guide Strap	400167
35	Grease Fitting	037032
43	Adjusting Screw (Sector Shaft)	021200
44	Retainer (Adjusting Screw)	062005
47	Jam Nut	G9419666
49	Vent Plug (Side Cover)	036201
50	Bleed Screw (Manual)	213705
51	Plug (Auto Bleed)	021397
52A	Fixed stop screw	021426
54	Auxiliary Port Plug (2)	G9410358
55	O-ring (2-Aux. Port Plug)	032229
57	O-ring (Relief Valve)	032200-153
59	Service Poppet Adjusting Screw	021407
60	Service Sealing Jam Nut	025119

Parts Vary by Specification*

Item	Description
5	Valve Housing
13	Input Shaft, Valve, Worm Assy.
19	Rack Piston
34	Housing
42	Sector Shaft
46	Side Cover Assembly
56	Relief Valve Cap
58	Relief Valve (2 piece)

*Contact Service/Sales for part numbers

Kits

Items	Description	Part Number
54 & 55	Port Plug & O-ring	415437-A1
56 & 57	Relief Valve Cap & O-ring	411061-A1
59 & 60	Adj. Screw & Jam Nut	021407-X1
2, 2B, 2C, 3, 4	Input Shaft Seal Kit	TAS000001
	TAS40 Seal Kit	TAS400004
	TAS55 Seal Kit	TAS550004
	TAS65 Seal Kit	TAS650012
	TAS85 Seal Kit	TAS850003

Parts Vary by Gear Size

Item	Description	TAS40	TAS55	TAS65	TAS85
6	Seal Ring (Valve Housing)	032829	032829	032616	032834
20	Teflon Seal Ring	032828	032830	032590	032547
21	O-ring (Back up; Rack Piston)	032827	032831	032615	032556
22	Poppet Seat and Sleeve Assy. (2)	409118-A2	409118-A2	409118-A2	409118-A6
23	Poppet (2-old design)	040210	040210	040210	040217
23A	Poppet (2-new design)	040248	040248	040248	040249
24	Poppet Spring	401662	401662	401662	401684
26	Push Tube	080154	080154	080154	080158
28	Ball Return Guide Halves (2) R.H.	400158	400160	400156	400162
	L.H.	400159	400165	400157	400163
37	Roller Bearing	070030	071032	071033	072004
41	Seal (2-Output)	478051	478040	478040	478084
45	Gasket (Side Cover)	HFB529000	HFB649000	HFB649000	TAS859000
48	Special Bolts (6 or 8-Side Cover)	021277	G223734	G223734	G223734
61	Dirt & Water Seal (Trunnion)	K301963	478095	478095	478096
63	Retaining Ring	401674	401650	401650	401685

Section 2 Initial Installation

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Initial TAS Installation

- Bolt gear to frame, torque to vehicle manufacturer's recommendation.
- Connect return line to TAS return port.
- Connect hydraulic line from pump to pressure port in TAS unit.
- Connect steering column to input shaft, torque pinch bolt to vehicle manufacturer's recommendation.
- Install pitman arm on output shaft, torque bolt to vehicle manufacturer's recommendation.

Initial Poppet Setting

For this procedure to work correctly, you must have: A new gear received from TRW or your vehicle manufacturer's aftermarket system, **or** a used gear on which poppet seats have been replaced or reset during gear disassembly procedures. **ALSO:** A fixed stop screw installed in the housing, or a poppet adjusting screw installed so that it duplicates the fixed stop screw length.

⚠ CAUTION **The axle stops and all steering linkage must be set according to vehicle manufacturer's specifications, and the pitman arm must be correctly aligned on the sector shaft for poppets to be set correctly.**

Full turn in one direction

1. With the engine at idle and the vehicle unloaded, turn the steering wheel to full travel in one direction until axle stop contact is made. Maximum input torque to be applied during this procedure is 40 lb rim pull (178 N) on a 20 in. (508mm) diameter steering wheel.

NOTE If you encounter excess rim pull effort, allow the vehicle to roll forward or jack up the vehicle at the front axle.

Full turn in other direction

2. Follow the same procedure while turning the steering wheel in the other direction. The poppets are now positioned to trip and reduce pressure as the steered wheels approach the axle stops in either direction.

Maintenance Tips

Never high-pressure wash or steam clean a power steering gear while on or off the vehicle. Doing so could force contaminants inside the gear and cause it to malfunction.

Do not attempt to weld any broken steering component. Replace the component with original equipment only.

Make sure vehicle wheel cut or clearances meet manufacturer's specifications, and make sure pitman arm timing marks are aligned properly to **prevent internal bottoming** of the steering gear.

Do not cold straighten, hot straighten, or bend any steering system component.

Always **clean off around the reservoir filler cap** before you remove it. Prevent dirt or other foreign matter from entering the hydraulic system.

Regularly check the fluid and the fluid level in the power steering reservoir.

Investigate and correct any external leaks, no matter how minor.

Keep tires inflated to correct pressure.

Replace reservoir filters according to requirements.

Never use a torch to remove pitman arm.

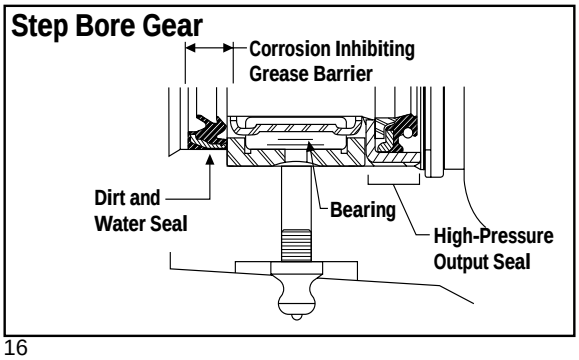
If you feel the vehicle is developing excessively **high hydraulic fluid temperatures**, consult with your vehicle manufacturer for recommendations.

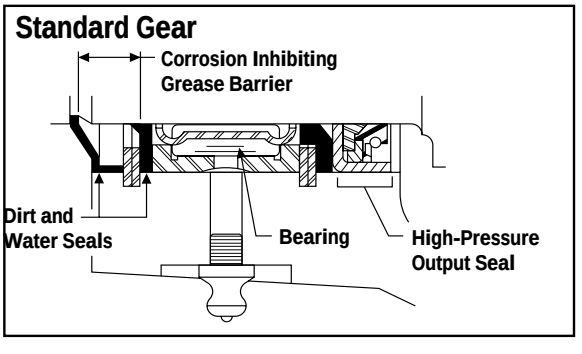
Investigate and immediately **correct the cause of any play, rattle, or shimmy** in any part of the steering system.

Make sure the steering column is aligned properly.

Maintain grease pack behind the output shaft dirt and water seal as a general maintenance procedure at least twice a year, in the Spring and Fall. Grease fitting is provided in housing trunnion. Use only NLGI grade 2 or 3 multipurpose chassis lube, and use only a hand operated grease gun on fitting. Add grease until it begins to extrude past the sector shaft dirt and water seal.

Encourage drivers to report any malfunctions or accidents that could have damaged steering components.





Section 3 On-Vehicle Service

Filling and Air Bleeding the System 17

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Poppet Readjustment

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- Dual Gears 27

Filling and Air Bleeding the System

Tools Required	Materials Required
5/16" Socket Lbf•in. Torque wrench	Hydraulic fluid

⚠ CAUTION **Make sure poppets are set correctly before beginning this procedure.**

Run engine for 10 seconds, turn off and fill reservoir

Hydraulic fluid

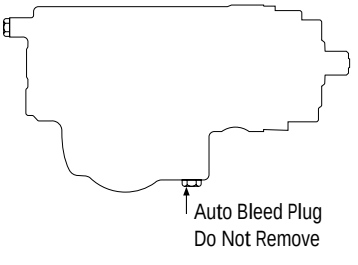
1. Fill the reservoir nearly full. Do not steer. Start and run the engine for 10 seconds, then shut it off. Check and refill the reservoir. Repeat at least three times, checking the reservoir each time.

⚠ CAUTION **Do not allow the fluid level to drop significantly or run out of the reservoir. This may induce air into the system.**

Run engine for 2 minutes, turn off and fill reservoir

Hydraulic fluid

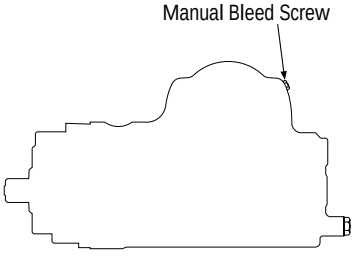
2. Start the engine and let it idle for 2 minutes. Do not steer. Shut off the engine and check the fluid level in the reservoir. Refill as required.



Steer vehicle

3. Start the engine again. Steer the vehicle from full left to full right several times. Add fluid, as necessary, to the full line on the dip stick.

Automatic bleed systems should now be free from trapped air. **Manual bleed systems continue with step 4.**



Allow air to bleed out from bleed screw

Lbf•in. Torque wrench
5/16" Socket

4. With engine idling, steer from full left turn to full right turn several times. Stop steering and loosen the manual bleed screw about one turn. Allow air and aerated fluid to "bleed out" until only clear fluid is seen. Close the bleed screw, refill the reservoir if required.

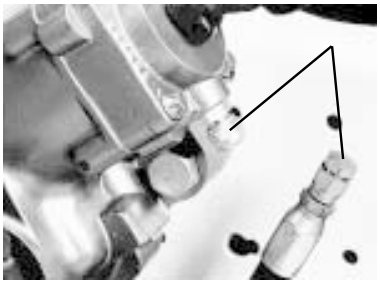
Repeat step 4 three to four times until all the air is discharged. Torque manual bleed screw to **45 lbf•in.**

⚠ CAUTION **Do not turn steering wheel with bleed screw loosened.**

Input Shaft Seal Replacement

Tools Required	Materials Required
Hammer J37073 Screwdriver	Clean cloth Drip pan High pressure fitting Hydraulic fluid Plug Shop towel

This procedure uses the vehicle's power steering pump to force out the input shaft seal. To use this procedure, the power steering pump should have a minimum of 1,500 psi available.



Disconnect return line

High pressure fitting
Plug

1. Disconnect return line from the steering gear and plug the line. Also cap the return port of the gear with a high pressure fitting.

Disconnect column

2. Remove the steering column from the gear input shaft.

Remove dirt & water seal

3. Remove the dirt and water seal from the steering gear. Save this seal to match the new seal to the correct size.

Remove retaining ring

Clean cloth
Screwdriver

4. Wipe out the grease and then remove the spiral retaining ring. Use a screwdriver inserted into the notch formed in the end of the ring. Be careful not to scratch the bore with the screwdriver.

Replace column

5. Slip the steering column back onto the input shaft with the pinch bolt installed, but not tightened.

Wrap exposed area

Drip pan
Shop towel

6. Tie or wrap a shop towel around the input shaft area and place a drip pan under the vehicle to catch the oil.

Fill reservoir

Hydraulic fluid

7. Add fluid as necessary, to the full line on the dip-stick. Do not mix fluid types.

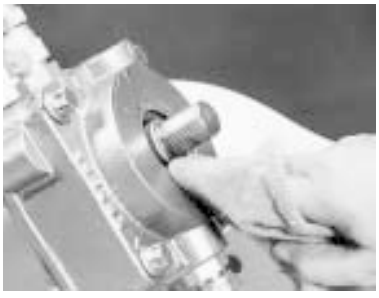
⚠ WARNING **Any mixture of fluid types, or use of any unapproved fluid could lead to seal deterioration and leaks. A leak could ultimately cause the loss of fluid, which could result in a loss of power steering assist.**

Force out the seal

8. With the vehicle in neutral, momentarily turn the starter (quickly turn off the engine if it starts).

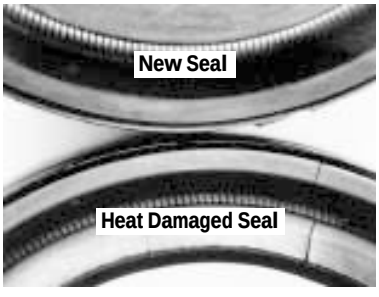
Remove input shaft seal

9. Remove the shop towel. Disconnect the steering column, and remove the input shaft seal.



Inspect seal area

10. Check the seal area of the valve housing for any seal fragments. Remove any that are found.



Inspect old seal

11. Check the seal for heat damage. If the seal is stiff and brittle, and not pliable like the new seal, it is probably heat damaged. Determine and fix the cause of excessive heat in the vehicle.

Install new seal

Hammer
J37073

12. Put clean grease 045422 on the inside dia. of the new input shaft seal, and place it over the input shaft. With the small dia. of tool J37073 against the seal, tap the tool until the tool shoulder is square against the valve housing. Remove any seal material that may have sheared off in the seal bore or retaining ring groove.

⚠ CAUTION **Do not use a socket to install this seal because you will not be able to control seal installation depth, possibly causing a leak.**

Install retaining ring

13. Insert new retaining ring into the groove.

Install dirt & water seal

14. Pack the end of the valve housing bore around the input shaft with grease 045422. Choose the correct size dirt & water seal by comparing the choices to the old seal, or by measuring the major diameter of the input shaft serrations (see chart next page). Apply more grease 045422 to the new dirt & water seal and install it over the input shaft. Seat it in the groove behind the serrations and against the valve housing.

Reconnect column

15. Reconnect the steering column to the input shaft and tighten the pinch bolt to torque level specified.

Reconnect return line

16. Reconnect the return line to the steering gear return port.

Air bleed system

17. Air bleed the system using the procedure on page 17.

Seal Part No.	Serration Size	Major Serration Dia.
478044	13/16" x 36	0.807 / 0.799
478060	7/8 x 36	0.866 / 0.857
478050	1" x 36	0.987 / 0.977
478050	1" x 79	1.008 / 1.000

Sector Shaft Adjustment

Tools Required	Materials Required
Screwdriver ¾" Socket ¾" Open end wrench	

This adjustment can only be completed on the vehicle if the adjusting screw jam nut is accessible. This nut is located on the side cover.

Photos in this section were taken on a mock frame rail for clarity.

Center the sector shaft

1. With the engine on, rotate the steering wheel (input shaft) until the timing mark on the sector shaft lines up with the mark on the housing. The line on the sector shaft should be at a 90° angle from the input shaft. The sector shaft is now on its "center of travel". Turn the vehicle off.

Remove the drag link

2. Remove the drag link from the pitman arm.

⚠ CAUTION **To avoid resetting the poppets, do not rotate the input shaft more than 1½ turns from the "center of travel" position while the drag link is disconnected.**

Check for sector shaft lash

3. From the "center of travel" position, grasp the pitman arm and gently try to rotate it back and forth. If looseness or lash is felt at this point, the sector shaft is out of adjustment.

Loosen jam nut

¾" Socket

4. Loosen the jam nut.

NOTE

If the gear is removed from the vehicle to adjust the lash:

- Leave the pitman arm connected to the gear.
- Best option is to follow the Final Adjustment procedure on page 63.
- Alternate option is to continue with step 5 of this procedure.

Position adjusting screw

Screwdriver

5. If no lash was detected in step 3, turn the shaft adjusting screw counterclockwise until you feel lash at the output shaft.

Adjust shaft

Screwdriver
¾" Open end wrench

6. Slowly turn the shaft adjusting screw clockwise until you feel no lash at the output shaft without using more than 10 lbf•ft (14 N•m) of torque. From this position, turn the screw clockwise ⅛ to 3/16 of a turn more. Hold the adjusting screw in place, and tighten the jam nut. **Final jam nut torque 43 lbf•ft** (58 N•m).

Recheck for lash

7. Turn the steering wheel ¼ turn each side of center, then back to center and recheck the pitman arm for lash. You should feel no lash; if there is lash, repeat steps 4, 6 and 7.

Connect drag link

8. Reconnect the drag link to the pitman arm according to manufacturer's specifications.

⚠ CAUTION **Maintain grease in the sector shaft bearing through the grease fitting in the housing using only a hand operated grease gun. Add grease until it begins to extrude past the dirt and water seal. Do not use a power grease gun because it will supply grease too fast; this could adversely affect the high pressure seal and contaminate the hydraulic fluid.**

Poppet Readjustment - Single Gears

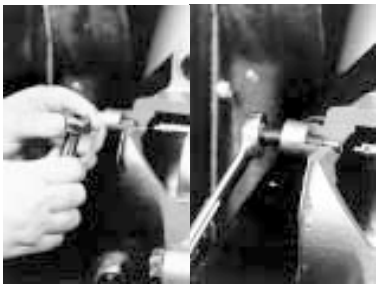
Tools Required	Materials Required
7/32" Allen wrench	Hydraulic fluid
5/8" Open end wrench	Jack
3/4" Open end wrench	
3/4" Socket	
Lbf•lb Torque wrench	

This resetting procedure will work in most cases with at least 1¾ hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.

Set axle stops, warm-up system

1. Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

   Start the engine and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.



Assemble adjusting screw into nut

2. If a new poppet adjusting screw and nut are being used, turn the screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

   Your steering gear will have either a fixed stop bolt or an adjusting screw. If the adjusting screw is already part of the steering gear, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

Remove poppet stop bolt

5/8" Open end wrench

3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of the housing.

   If the unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.

Turn adjusting screw assembly into housing

7/32" Allen wrench

4. Turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 7/32" Allen wrench. Tighten the sealing nut against the housing.

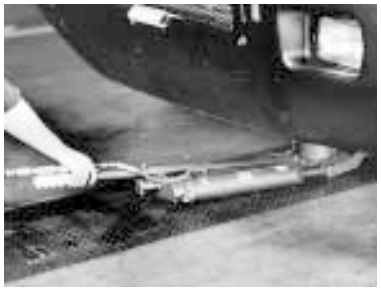
⚠ CAUTION **If the drive end of the screw is below the face of the nut, the popet seat flange will break during step 7d.**

Refill reservoir

Hydraulic fluid

5. Refill the system reservoir with approved hydraulic fluid.

⚠ CAUTION **Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.**



Jack up vehicle

Jack

6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

Push upper poppet out to prepare it for setting

7. **a)** Start the engine and let it run at idle speed.

b) Note which output shaft timing mark is nearest the housing piston bore.

c) Turn the steering wheel in the direction that makes this timing mark move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made.

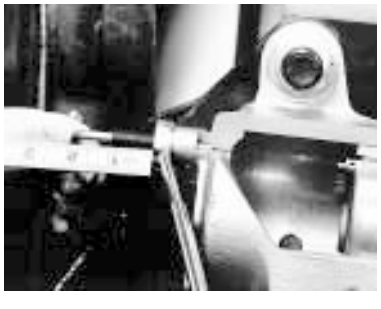
d) Pull hard on the steering wheel (put up to 40 lb rim pull on a 20" dia. steering wheel) after the axle stop is contacted.

Set upper poppet

8. **a)** Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted.

b) Pull hard on the steering wheel (put up to 40 lb rim pull on a 20" dia. steering wheel).

c) Release the steering wheel and shut off the engine.



Back out adjusting screw

7/32" Allen wrench
3/4" Open end wrench

9. Loosen the sealing nut and back out the adjusting screw until 1" is past the nut. Tighten the sealing nut against the housing.

⚠ CAUTION **Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.**

Set lower poppet

10. **a)** Start the engine and let it idle.

    b) Turn the steering wheel in the original direction (end of timing mark toward adjusting screw), until axle stop contact is made.

    c) Hold the steering wheel in this position (with up to 40 lb rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing step 11.

Position adjusting screw

7/32" Allen wrench
3/4" Open end wrench
3/4" Socket
Lbf•ft Torque wrench

11. **a)** With steering wheel held tightly at full turn loosen the jam nut and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using **finger-pressure only (don't use a ratchet)**, until the Allen wrench stops. Do not attempt to turn it in further. Pause the turning-in process each time the driver releases the steering wheel; continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw 3¼ turns and tighten the sealing nut. Torque sealing nut to **35 lbf•ft**.

The procedure is complete

12. The poppets have now been completely reset. Lower the vehicle. Check the reservoir and fill if required.

⚠ WARNING **The length of the adjusting screw beyond the nut must be no more than 1 1/16" for proper thread engagement.**

NOTE The length of adjusting screw beyond the sealing nut may be different for each vehicle.

Poppet Readjustment - Dual Gears

Mirror Image Systems and Reversed Image Systems

Before setting poppets on a dual gear system, you must determine whether the system has mirror image gears or reversed image gears. The procedures are slightly different for each type of system.

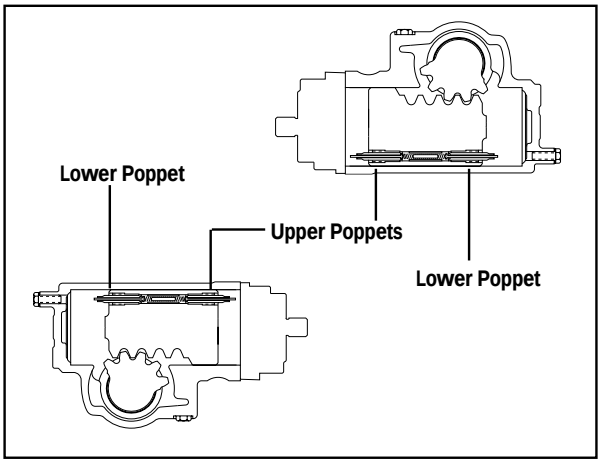
1. Park the vehicle with the wheels turned all the way to the axle stop in either direction. Turn the vehicle off.

2. Look at the output shaft timing mark nearest the housing piston bore on the master gear. Is this mark pointing toward the poppet screw or away from it?

3. Now check the same timing mark on the rotary cylinder. Does it point toward the poppet screw or away from it?

   If they point to opposite ends of the gears you have a mirror image system.

   If they both point toward the poppet screws or both point toward the end opposite the poppet screws, you have a reversed image system.



Poppet Readjustment - Dual Gears - Mirror Image

Tools Required	Materials Required
7/32" Allen wrench	Hydraulic fluid
5/8" Open end wrench	Jack
3/4" Open end wrench	
3/4" Socket	
Lbf•lb Torque wrench	

This resetting procedure will work in most cases with at least 1¾ hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.

1. Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

   Start the engine, and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.

2. If new poppet adjusting screws and nuts will be used, turn each screw into the non-sealing end of the jam nut until the drive end of screw is flush with the nut.

   Your steering gear and rotary cylinder will both have either fixed stop bolts or adjusting screws. If the adjusting screw is already part of the gear or cylinder, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolt (if equipped) and washer (if equipped) from the lower end of housing on both the gear and the cylinder.

   If either unit has a poppet adjusting screw and sealing nut that need to be replaced, remove and discard them.

4. On both the master gear and the rotary cylinder, turn the adjusting screw and sealing nut assembly, without rotating the nut on the screw, into the housing until the nut is firmly against the housing using a 7/32" allen wrench. Tighten the sealing nut against the housing.

5. Refill system reservoir with approved hydraulic fluid.

   ⚠ CAUTION **Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.**

6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

7. **a)** Start the engine and let it run at idle speed.

   b) Turn the steering wheel in the direction that makes the timing mark on the master gear move toward the adjusting screw just installed. Turn in this direction until axle stop contact is made.

   c) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel) after the axle stop is contacted.

8. **a)** Turn the steering wheel in the opposite direction (end of timing mark on the master gear away from adjusting screw) until the other axle stop is contacted.

   b) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel).

   c) Release the steering wheel and shut off the engine.

9. Loosen the sealing nut and back out the adjusting screw on the master gear until 1" is past the nut. Tighten the sealing nut against the housing.

   ⚠ CAUTION **Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.**

10. **a)** Start the engine and let it idle.

    b) Turn the steering wheel in the original direction (end of timing mark on the gears toward adjusting screw), until axle stop contact is made.

    c) Hold the steering wheel in this position (with 40 lbs. rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing steps 11 & 12.

11. **a)** With steering wheel held at full turn, loosen the jam nut on the master gear and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using finger- pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw 3¼ turns and tighten the sealing nut. Torque the sealing nut to **33-37 lbf•ft.**

    d) Release the steering wheel and shut off the engine.

12. Loosen the sealing nut and back out the adjusting screw on the rotary cylinder until 1" is past the nut. Tighten the sealing nut against the housing.

13. **a)** Start the engine and let it idle.

    b) Turn the steering wheel in the opposite direction (end of timing mark on master gear away from adjusting screw), until axle stop contact is made.

    c) Hold the steering wheel in this position (put up to 40 lb. rim pull on a 20" dia. steering wheel) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing step 14

14. **a)** With steering wheel held at full turn, loosen the jam nut on the rotary cylinder and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using finger- pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw 3¼ turns and tighten the sealing nut. Torque the sealing nut to **33-37 lbf•ft.**

    d) Release the steering wheel and shut off the engine.

15. The poppets have now been completely reset. Lower the vehicle . Check the reservoir and fill if required.

⚠ WARNING **The length of the adjusting screw beyond the nut must be no more than 1 1/16" for proper thread engagement.**

NOTE The length of adjusting screw beyond the sealing nut may be different for each vehicle.

Poppet Readjustment - Dual Gears - Reversed Image

Tools Required	Materials Required
7/32" Allen wrench	Hydraulic fluid
5/8" Open end wrench	Jack
3/4" Open end wrench	
3/4" Socket	
Lbf•lb Torque wrench	

This resetting procedure will work in most cases with at least 1¾ hand-wheel-turns from each side of center. If you're making a large reduction in wheelcut and this procedure does not work, you may have to replace or internally reset the poppets using the procedure described in the Poppet Component section of this Service Manual.

1. Set the axle stops to vehicle manufacturer's wheelcut or clearance specifications.

   Start the engine, and allow the vehicle to idle for 5-10 minutes to warm the hydraulic fluid. Shut off the engine.

2. If new poppet adjusting screws and nuts are being used, turn the screws into the non-sealing end of the jam nuts until the drive end of screw is flush with the nut.

   Your steering gear and rotary cylinder will have either fixed stop bolts or adjusting screws. If the adjusting screw is already part of the steering gear or cylinder, back the nut off of the adjusting screw until it is flush with the end of the adjusting screw.

3. Make sure the engine is off and the road wheels are in straight ahead position. Remove and discard the poppet fixed stop bolts (if equipped) and washers (if equipped) from the lower end of housing on both the master gear and the rotary cylinder.

   If the unit has poppet adjusting screws and sealing nuts that need to be replaced, remove and discard them.

4. Turn the adjusting screws and sealing nut assemblies, without rotating the nut on the screw, into the housing until the nut is firmly against the housing, on both the master gear and the rotary cylinder, using a 7/32" allen wrench. Tighten the sealing nut against the housing.

5. Refill system reservoir with approved hydraulic fluid.

   ⚠ CAUTION **Do not mix fluid types. Mixing of transmission fluid, motor oil, or other hydraulic fluids will cause seals to deteriorate faster.**

6. Place a jack under the center of the front axle and jack up the front end of the vehicle so the steer axle tires are off the ground.

7. **a)** Start the engine and let it run at idle speed.

   b) Note which output shaft timing mark is nearest the housing piston bore.

   c) Turn the steering wheel in the direction that makes this timing mark move toward the adjusting screws just installed on both the gear and the cylinder. Turn in this direction until axle stop contact is made.

   d) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel) after the axle stop is contacted.

8. **a)** Turn the steering wheel in the opposite direction (end of timing mark away from adjusting screw) until the other axle stop is contacted.

   b) Pull hard on the steering wheel (put 40 lbs. rim pull on a 20" dia. steering wheel).

   c) Release the steering wheel and shut off the engine.

9. Loosen the sealing nut and back out the adjusting screw until 1" is past the nut on both the master gear and the rotary cylinder. Tighten the sealing nuts against both housings.

   ⚠ CAUTION **Do not hold the steering wheel at full turn for more than 10 seconds at a time; the heat build-up at pump relief pressure may damage components.**

10. **a)** Start the engine and let it idle.

    b) Turn the steering wheel in the original direction (end of timing mark toward adjusting screw), until axle stop contact is made.

    c) Hold the steering wheel in this position (with 40 lbs. rim pull) for 10 seconds, then release. Repeat this hold and release process as many times as necessary while completing steps 11 and 12, first on the master gear, then on the rotary cylinder.

11. **a)** With steering wheel held at full turn, loosen the jam nut on the master gear, and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using finger- pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw 3¼ turns and tighten the sealing nut. Torque nut to **33-37 lbf•ft.**

12. **a)** With steering wheel held at full turn, loosen the jam nut on the rotary cylinder and hold it in place with a wrench.

    b) Turn the adjusting screw in (clockwise) using finger- pressure only (don't use a ratchet), until the Allen wrench comes to a stop. Do not attempt to turn it in farther. Pause the turning-in process each time the driver releases the steering wheel; Continue turning only while the wheel is held at full turn.

    c) Back off the adjusting screw 3¼ turns and tighten the sealing nut. Torque nut to **33-37 lbf•ft.**

13. The poppets on both the master gear and rotary cylinder have now been completely reset. Lower the vehicle . Check the reservoir and fill if required.

⚠ WARNING **The length of the adjusting screw beyond the nut must be no more than 1 1/16" for proper thread engagement.**

NOTE The length of adjusting screw beyond the sealing nut may be different for each vehicle.

Section 4 Reseal & Repair

Disassembly 33

Inspection 41

Assembly 43

Internal Damage Repair (by reference)

- Poppet Component Replacement 51
- Valve Housing Worm Screw Disassembly 53
- Roller Bearing or Retaining Ring Replacement 60
- Roller Bearing Replacement - Step Bore Gear 61
- Replace Housing Ports, Plugs, Screws, Fittings 62

Final Adjustments 63

Disassembly Preparation

Stop the vehicle with wheels pointed straight ahead.

Clean off all outside dirt from around fittings and hose connections before you remove the gear.

Remove input and output shaft connections per vehicle manufacturer's instructions.

⚠ WARNING **When using a chisel to spread a pinch bolt-type pitman arm boss for assembly or removal from the shaft, maintain a firm grip on the chisel at all times. Failure to do this may result in the chisel flying loose which could cause an injury. Never leave the chisel wedged in the pitman arm boss. If you cannot remove the pitman arm from the shaft with a chisel and your hands, remove the chisel from the arm boss and use a puller only to remove pitman arm.**

⚠ CAUTION **Do not use a hammer on the pitman arm to remove it from sector shaft as internal damage to steering gear could result. Be sure there is no spreading wedge left in the pitman arm boss before tightening pitman arm clamp bolt after assembly on sector shaft. Do not pound the universal joint or input shaft coupling on or off the input shaft as internal damage to the steering gear can result.**

⚠ CAUTION **Unless the poppet adjuster seat and sleeve assemblies (22) are to be removed and replaced or reset for automatic poppet adjustment, or a manual adjustment with a service poppet adjuster screw (59) and nut (60) is anticipated, do not allow the input shaft on a steering gear with the automatic poppet adjustment feature to rotate more than 1.5 input shaft revolutions from "straight ahead position" when the output shaft is disconnected from the vehicle steering linkage; this could disrupt the poppet setting achieved at initial installation. The steering gear is in the "straight ahead position" when the timing marks on the end of the housing trunnion and sector shaft are aligned.**

Remove the supply and return lines from the gear, and immediately plug all port holes and fluid lines.

⚠ WARNING **TAS steering gears can weigh up to 110 pounds dry. Exercise caution when you remove, lift, carry, or fix in a bench vise.**

Remove the steering gear from the vehicle and take it to a clean work surface.

Clean and dry the gear before you start to disassemble it.

As you disassemble the gear, clean all parts in clean, OSHA approved solvent, and air blow-dry them only.

⚠ WARNING **Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.**

⚠ WARNING **Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.**

⚠ CAUTION **Never steam clean or high-pressure wash hydraulic steering components. Do not force or abuse closely fitted parts. Use care that bearing and sealing surfaces are not damaged by the assembly and disassembly procedures.**

Keep each part separate to avoid nicks and burrs.

Discard all seals, o-rings, and gaskets removed from the gear. Replace them with new parts only.

The steering gear should be identified to the vehicle from which it was removed. The poppet adjuster seat and sleeve assemblies are set for that particular vehicle only.

Disassembly

Tools Required

Allen wrenches
Pocket knife
Ratchet
Rolling head pry bar
Rubber mallet
Screwdriver
Sockets:
- •Standard
- •Torx

Vise

Materials Required

Emery cloth
Masking tape

Position gear in vise

1. Put the steering gear in a vise, clamping firmly against the housing mounting flange or boss. Input shaft should be horizontal; side cover and valve housing are accessible for disassembly.

⚠ CAUTION **Do not clamp against body of housing. If mounting boss or flange is not accessible, fabricate and attach a mounting plate to the housing mounting bosses.**

Unplug ports

Appropriate size socket or open-end wrench

2. Prepare for fluid drainage and unplug hydraulic ports.

Position sector shaft

3. Rotate the input shaft until the timing mark on the end of the sector shaft is in line with the timing mark on the end of the housing. This will position the sector shaft for removal.

Remove dirt & water seal

Small screwdriver

4. **Standard gears only** - Remove and discard dirt & water seal (39) from the housing trunnion.

Clean sector shaft

Fine grade emery cloth

5. Remove any paint or corrosion from the exposed area of the sector shaft (42).

Tape sector shaft

Masking tape

6. Tape the serrations and bolt groove of the sector shaft with one layer of masking tape. The tape should not extend onto the sector shaft bearing diameter.

Remove jam nut

¾" Socket

7. Remove the sector shaft adjusting screw jam nut (47).

Remove side cover bolts

15⁄16" Socket or 13⁄16" Socket

8. Be prepared for more fluid drainage and remove the six or eight special bolts (48) from the side cover (46).

Remove side cover

Soft mallet

9. Be prepared for more fluid drainage and remove the side cover and sector shaft assembly from the gear. You may start the shaft and cover assembly removal by tapping the end of the shaft lightly with a soft mallet or wooden hammer handle.

Discard gasket

10. Remove and discard the side cover gasket (45).

Remove vent plug

11. Remove and discard the vent plug (49).

Remove sector shaft from cover

Screwdriver

12. Screw sector shaft adjusting screw (43) clockwise through the side cover and pull the sector shaft out of the side cover.

Remove side cover seal

⅜" Drive socket
Rolling head pry bar

13. **⚠ CAUTION** **Don't damage the bore or DU bushing when removing the seal. TAS85 gears are not equipped with the DU bushing.**

Clamp the side cover in a vise. Place a standard ⅝" or 11⁄16" - ⅜ drive socket in the center of the side cover. pry the seal (41) out with a rolling head pry bar, using the socket for support. Discard the seal and remove the socket.

Inspect adjusting screw and retainer

14. Inspect the sector shaft assembly for damaged adjusting screw threads. The retainer (44) must be securely staked in place. The adjusting screw must rotate by hand with no perceptible end play (lash).

Remove relief valve components

⅞" Socket

15. If equipped, remove relief valve cap (56), o-ring (57) and two-piece relief valve (58) from the valve housing. Discard the o-ring.

Remove dirt & water seal

16. Remove and discard the dirt & water seal (2, 2B or 2C) from the input shaft (13 or 13A). Save this seal for comparison with the new seal.

Clean input shaft

Fine grade emery cloth

17. Clean any paint or corrosion from the exposed area of the input shaft.

Remove valve housing bolts

Torx socket E-16 or E-18

18. Remove the four torx head valve housing bolts (1).

Remove valve housing, worm and rack subassembly

19. Be prepared for more fluid drainage and remove the rack piston subassembly. Place the assembly on a clean cloth. For the TAS85 it may help to rotate the input shaft to move the rack piston toward the lower end of the housing. This will force the valve housing to exit the main housing.

⚠ CAUTION **The set position of poppet seat and sleeve assemblies (22) must not be disturbed if the poppets are not going to be replaced or reset during disassembly.**

Pocket knife

19A. **NOTE** If your gear is short "V" construction, the rack piston seal is on the end of the rack piston farthest from the input shaft. Remove the seal before removing the valve housing assembly to prevent the Teflon rack piston seal ring (20) from "hanging up" when it exits the housing. Expose the seal through the sector shaft cavity, then cut and remove the seal ring from the rack piston.

Remove seals

20. Remove and discard the valve housing seal rings (6 & 7).

⚠ CAUTION **Do not remove the input shaft, valve worm assembly or balls from the rack piston until the ball return guides are removed as damage to the ball guides will occur.**

Remove ball return guide cap/strap

5⁄32" Allen wrench or T-30 Torx wrench

21. Remove and discard the two special sealing screws (31). Remove the ball return cap (30) and seal (29), or strap (32), discard the seal.

OR

Remove ball return guide clip

1/2" Socket

21A. Bend down the two tabs (tangs) that are against the hex head bolts. Remove two bolts and the clip. Discard the clip.

Remove ball return guides

Screwdriver

22. Make sure the rack piston is on a cloth so the steel balls that fall out won't roll very far. Remove ball return guide halves (28) by carefully inserting a screwdriver between the rack piston and guides.

NOTE Left hand ball return guide halves are copper plated for identification and right hand guides are not plated. **Retain the guides for reassembly**.

Remove steel balls

23. Remove the steel balls (27) from the rack piston (19) by rotating the input shaft, valve worm assembly until the balls fall out. Place the balls and return guides in a cup or other container. Count the balls, and make sure all have been removed.

> **⚠ CAUTION** **The steel balls are a matched set. If any are lost, the set must be replaced by service balls. Number of factory balls installed: TAS40-29, TAS55-31 (30 if date code is 337-89 or earlier), TAS65-32, TAS85-34.**

Separate rack piston from worm subassembly

24. Remove the input shaft, valve/worm, valve housing subassembly from the rack piston.

Remove seal ring and o-ring

Pocket knife

25. Cut and remove the Teflon seal ring (20) and o-ring (21) from the rack piston if not removed during disassembly step 19A.

Inspect poppet assemblies

26. Push poppet stems, they should spring back. Push poppet seat, it should not move by hand. If components are bent or broken, poppet stems don't spring back, or poppet seat moves by hand, go to **Poppet Component Replacement** section on page 51. Otherwise, proceed to step 27.

> **NOTE** TRW recommends the poppet adjuster seat and sleeve assemblies (22) not be removed unless replacement of poppet components is required.

Inspect valve housing and worm screw

27. Inspect valve housing/worm screw subassembly for heat damage or bearing roughness. If these conditions are present, or if there was excessive internal leakage, or if preload adjustment is required, go to **Valve Housing/Worm Screw Disassembly** procedures on page 53. If not, proceed to step 28.

Remove retaining ring (if equipped)

28. **Standard gears only** - Remove the retaining ring (36) that is closest to the output end of the housing trunnion.

Remove dirt seal

Screwdriver

29. **Standard gears** - Remove and discard dirt seal (38).

Step bore gears - Remove and discard the dirt and water seal (61).

Remove pressure seal (and spacer washer if equipped)

Screwdriver

30. **Standard gears** - Insert a screwdriver into the housing bearing bore from the trunnion end, and carefully push the seal (41) and spacer washer (40) out of the other end of the bearing bore ***without damaging the sealing area of the bore***. Discard the seal.

Step Bore gears - Remove the retaining ring (63) through the side cover opening. Then insert a screwdriver through the trunnion opening, and carefully push the seal (41) out ***without damaging the sealing area of the bore***. Discard the seal.

Inspect roller bearing

31. **Standard gears** - Inspect roller bearing (37) in the housing for brinelling or spalling. Inspect retaining ring for damage. If replacement of either part is required, go to **Roller Bearing or Retaining Ring Replacement** on page 60. If not, proceed to step 32.

Step Bore gears - Inspect the roller bearing (37) for brinelling or spalling. If replacement is required, go to **Roller Bearing Replacement - Step Bore** on page 61. If not, proceed to step 32.

Inspect housing screws, and plugs

32. Inspect the following for damage:

- Poppet fixed stop screw (52 or 52A) and washer (53) if equipped.
- Poppet adjusting screw (59) and sealing nut (60)
- Auto-bleed plug (51)
- Manual bleed screw (50)
- Auxiliary port plugs (54) and o-rings (55)

If any are damaged, go to **Replace Housing Ports, Plugs and Screws** on page 62. If not, proceed to the Inspection Section.

Inspection

Make sure all sealing surfaces and seal cavities are free from nicks and corrosion. Any nicked or corroded surface requires part replacement to ensure proper sealing.

Wash all parts in clean, OSHA approved solvent. Air blow them dry only.

⚠ WARNING **Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.**

⚠ WARNING **Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.**

⚠ WARNING **Any of the following conditions present in the steering gear indicates impact damage.**

Condition	Area
Brinelling	**• Ball track grooves of rack piston** **• Ball track grooves of worm screw** **• Bearing area of sector shaft** **• Thrust washers and bearings in valve housing**
Cracks or Breaks	**• Bearing area of sector shaft** **• Sector shaft teeth** **• Rack piston teeth** **• Housing** **• Thrust washers and bearings in valve housing** **• Worm screw**
Twisted serrations	**• Output shaft serrations**

If one of these conditions is found in one component, be sure to inspect all components carefully for signs of impact damage. Replace components noted in individual inspection steps below if you suspect impact damage. Failure to replace all damaged components could result in a serious vehicle accident.

Inspect rack piston teeth

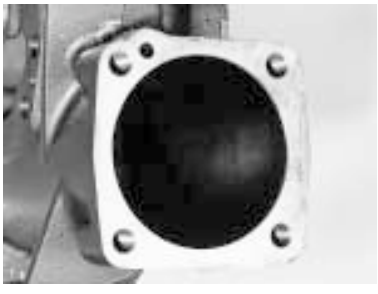
1. Inspect the rack piston (19) teeth for cracks or obvious damage. If teeth are damaged, replace the rack piston, sector shaft (42) and set of balls (27).

Inspect rack piston and worm ball track grooves

2. Inspect the rack piston (19) ball track grooves for brinelling or spalling. If either condition exists, replace the input shaft, valve/worm assembly, valve housing, rack piston subassembly and balls.

Inspect input shaft, valve/worm assembly sealing areas

3. Inspect the sealing area of input shaft and valve (13 or 13A) for nicks, and damage. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, replace the input shaft, valve worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.



Inspect housing cylinder bore

4. Inspect the housing (34) cylinder bore. some scoring marks are normal. If there was internal leakage greater than 1 gal/min, make sure there are no damaged seals before replacing the housing.

Inspect housing faces

5. Inspect the housing faces for nicks that would prevent proper sealing. Replace the gear housing if these nicks are present and cannot be easily removed with a fine-tooth flat file without changing the dimensional characteristics.

Inspect side cover bushing/bearing

6. **TAS40, 55, 65:** Inspect side cover (46) DU bushing for damage. Also check side cover bushing to sector shaft clearance. If damage exists, or if clearance exceeds .008" (0.20 mm) replace side cover/bushing assembly.

TAS85: Inspect roller bearing in side cover assembly (46) for brinelling or spalling. If either condition exists, replace the side cover and bearing assembly.

Inspect sector shaft assembly

7. Inspect the sector shaft (42) bearing and sealing areas and sector teeth contact surfaces for brinelling, spalling or cracks. Run your fingernail edge across these areas to detect steps. Remove masking tape from the shaft and inspect for twisted or otherwise damaged serrations. If any of these conditions exist, replace the sector shaft.

NOTE A service sector shaft will come assembled with the adjusting screw (43) and retainer (44).

Assembly Preparation

Wash all parts in clean, OSHA approved solvent. Air blow-dry them only.

⚠ WARNING **Because they are flammable, be extremely careful when using any solvents. Even a small explosion or fire could cause injury or death.**

⚠ WARNING **Wear eye protection and be sure to comply with OSHA or other maximum air pressure requirements.**

Replace all seals, seal rings, and gaskets with new ones each time you disassemble the gear.

TRW Commercial Steering Division makes complete seal kits available. These parts can be purchased through most OEM parts distributors. Contact your local dealer for availability.

Assembly

Tools Required

- 5/32" Allen wrench
- Lbf•ft Torque wrench
- Hammer
- J37705 (TAS40)
- J37071 (TAS55/65)
- J38779 (TAS85)
- Press
- Punch
- Ratchet
- Screwdriver
- Sockets
- Torx sockets
- Vise

Materials Required

- ATF oil
- Grease (Exxon Unirex* RS460
- Masking tape
- Seal kit: Ross TAS400004, TAS550004, TAS650012, TAS850005
- 7/16"-14 x 7¼" All Thread

Install dirt seal

1. **Standard Gears** - Install new dirt seal (38) into the trunnion end of the housing sector shaft bore and against the bearing, with the seal lip out.

Install retaining ring

2. **Standard gears only** - Install the outside retaining ring (36), seating it firmly in the housing retaining ring groove.

*Trademark of Exxon Oil Corp.

Install washer

3. **Standard gears only** - Install washer (40) into the side cover side of the housing seal bore with the small diameter piloted into the retaining ring.

NOTE If you are working with a housing with an unmachined trunnion face, you may need to square the housing to the press with shims for step 4.

Press seal into housing

J37705 (TAS40)
J37071 or J37071-A (TAS55/65)
J38779 (TAS85)
Press

4. **All gears** - Assemble new seal (41) onto bearing and seal tool (short end) so the lip with the garter spring is toward the shoulder of the tool. Working from the side cover side of the housing, pilot the seal tool into the washer and bearing and press with a force of 100-800 lb (445-3,560 N) until the seal is seated firmly.

Step Bore gears only - Install the inside retaining ring (63) from the side cover opening. Seat the ring firmly in the retaining ring groove.

Grease the bearing and seal area

Grease

5. **Standard gears** - Liberally pack the area between dirt seal (38) and pressure seal (41) including roller bearing with clean, high temperature industrial grease, 045422 Exxon Unirex* RS460.

Install dirt & water seal

J37071 or J37071-A
Press

6. **Step Bore gears** - Install the dirt & water seal (61) with the bearing and seal tool (long end), making sure it is not cocked. Press the seal only until it seats against the bearing, don't push it in farther.

Liberally pack the roller bearing and new seals with clean, high temperature industrial grease, Exxon Unirex* RS460.

Assemble seal rings

7. Lightly oil new seal ring (7) and assemble in valve housing mounting face groove.

TAS40, 55, 65: Oil new seal ring (6) and assemble in valve housing mounting face groove.

TAS85: Oil new seal ring (6) and assemble in valve housing pilot groove.

*Trademark of Exxon Oil Corp.

Install rack piston o-ring and seal ring

8. Install a new backup o-ring (21) and then a new Teflon seal ring (20) on rack piston (19). Do not over-stretch these rings as you install them. Do not allow the Teflon seal ring to be twisted.

Position rack piston in housing

9. Apply clean oil to housing cylinder bore. Place the rack piston (19) in the housing piston bore with ball return guide holes up.

Insert worm and valve assembly into rack piston

7⁄16"-14 x 7¼" All Thread

10. Insert the worm screw into the rack piston close to maximum depth, without the valve housing making contact with the poppet stem. Insert two 7⁄16"-14 All threads through valve housing bolt holes and tighten into housing to support the worm screw. Line up rack piston ball guide holes with the worm ball track grooves by rotating the input shaft.

Assemble ball return guide halves

11. Assemble the ball return guide halves (28) into the rack piston until seated, rotate the input shaft slightly if necessary.

⚠ WARNING **Do not seat guides with a hammer. Damage to guides can result in subsequent lockup or loss of steering.**

⚠ CAUTION **If a new rack piston (19) or a new input shaft, valve, worm subassembly (13 or 13A) is being assembled, the balls (27) removed from the unit must be discarded and a service ball kit utilized. The balls in a service ball kit are sized to function in the ball track guide path as altered by component replacement.**

⚠ CAUTION **When using the service ball kit, use the correct quantity of service balls: TAS40-29, TAS55-31, TAS65-32, TAS85-34.**

Assemble balls

12. **Hold the ball return guides (28) firmly in place during this entire procedure.** Insert as many of the steel balls as you can through the hole in the top of the ball return guides. Rotate the input shaft to pull the balls down and around the ball track guide path. Continue until the correct number of balls are in the ball track guide path.

⚠ WARNING **Hold down the ball return guides until cap or clip is reinstalled. Failure to hold the guides will result in a trapped ball or balls, which could cause a vehicle accident. If the ball guides become unseated (raise up) at any time, repeat the procedure starting at step 9.**

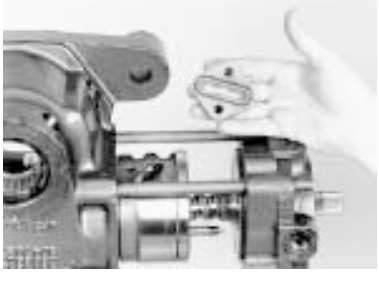
⚠ WARNING **The correct number of balls are required for proper gear operation. Count the balls and insert each carefully as in step 11.**

	TAS40	TAS55	TAS65	TAS85
Original	29	30/31*	32	34
Service	29	31	32	34

***TAS55 gears built prior to 338-89 were equipped with 30 balls.**

⚠ CAUTION **Do not allow valve housing to contact the poppet stem or move more than 2½ inches (69.1 mm) from upper end of rack piston during these procedures. This could incorrectly reset the poppet, or back out worm beyond closed ball loop, trapping balls.**

⚠ CAUTION **Remove any fluid present in the two screw holes. Fluid in these holes could cause improper clamp load when torquing the cap or strap screws.**



Assemble ball return guide cap

- 5/32" Allen or T-30 Torx socket
- Lbf•in. Torque wrench
- Grease

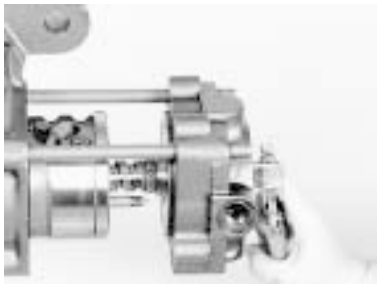
13. Place a new ball return guide cap seal (29) in the seal groove of the cap (30). Make sure the seal makes full contact with the rack piston surface. Install two new Allen or Torx head screws (31) and torque each screw alternately until a final torque of **18 lbf•ft** (24.5 N•m) is achieved.

⚠ CAUTION **Ball cap seal is greased to hold seal in groove while assembling. Be sure not to trap the seal outside of the groove during reassembly.**

Assemble ball return guide strap

5⁄32" Allen or T-30 Torx socket
Lbf•in. Torque wrench
Grease

14. If your gear was equipped with the ball return guide strap (32), or if it was equipped with the clip, install the new ball return guide strap. Position it on the rack piston, install two new Allen or Torx head screws (31) and torque each screw alternately until a final torque of **18 lbf•ft** (24.5 N•m) is achieved.



Rotate input shaft to check for proper installation of balls

15. Rotate the input shaft from one end of travel to the other without contacting the poppet stem to the valve housing, and without moving the valve housing face more than 2½" (69.1 mm) from input end (upper end) of rack piston. If you cannot rotate the input shaft, remove the balls and reassemble them.

⚠ WARNING **If you install a gear on a vehicle with the worm shaft unable to rotate, the gear will not function correctly. Steering and gear failure may result.**

Install rack piston, worm, valve assembly

Oil

16. Apply clean oil to Teflon seal ring (20) on rack piston. Make sure there is a space of ⅜ - ½" (10.0-13.0 mm) between valve housing (5) and poppet stem to prevent poppet contact at either end. Remove the All Threads, and push the rack piston assembly into the housing with the rack piston teeth toward the sector shaft cavity. Line up the valve housing cylinder feed hole with the gear housing feed hole. Make sure both o-rings in the valve housing remain in position.

⚠ CAUTION **Do not damage the seal ring (19) while installing the rack piston into housing. If the seal ring end of rack piston enters the housing first, the seal ring will be destroyed when the rack is removed.**

⚠ CAUTION **The poppet seat and sleeve assemblies (22) must not bottom against the internal poppet stops in the steering gear until the gear is installed on the vehicle and the poppet adjustment procedures are performed.**

Install valve housing bolts

E-16 Torx socket (TAS40, 55, 65)
E-18 Torx socket (TAS85
Lbf•ft Torque wrench

17. Lubricate and install the four valve housing bolts (1) into the housing. Torque the **TAS40, 55 and 65 bolts alternately to 80 lbf•ft** (108.5 N•m). Torque **TAS85 bolts to 118 lbf•ft** (160 N•m).

Install relief valve parts

⅞" Socket
Lbf•ft Torque wrench

18. If the gear is equipped with a relief valve, assemble a new o-ring (57) on relief valve cap (56). Assemble the small end of tapered spring onto the pin on the relief valve cartridge and insert the assembly (58), (large end of tapered spring end first) into the relief valve cap cavity. Turn the relief valve cap as assembled into the valve housing and torque to **30 lbf•ft** (41 N•m).

Lubricate side cover bushing/ bearing

19. **TAS40, 55, 65:** Lightly oil DU bushing. **Do not grease.**

TAS85 only: Apply a generous amount of Exxon Unirex* RS460 (do not substitute another type of grease) to the caged bearing assembly inside the side cover.

⚠ CAUTION **This bearing is sealed and will receive no lubrication from the hydraulic fluid in the gear. Failure to use the proper grease could result in premature bearing wear.**

Press seal in side cover

J37705 (TAS40)
J37071 or J37071-A (TAS55/65)
J38779 (TAS85)
Press

20. Grease and assemble new seal (41) onto installation tool so the side with the garter spring is against the shoulder of the tool. Pilot the tool into the side cover (46) with a force of 100-800 lb (445-3560 N) until it is seated against the bearing or bushing.

⚠ CAUTION **Make sure the OD of the seal, and the ID of the bore are free from grease and dust, for proper engagement of the seal.**

Lubricate sector shaft

21. **TAS40, 55, 65:** Lightly oil short bearing area of sector shaft. **Do not grease.**

TAS85 only: Apply a generous amount of Exxon Unirex* RS460 to the short bearing area of the sector shaft.

Install sector shaft into side cover

Screwdriver

22. Insert the sector shaft (42) into the side cover subassembly (46), and screw the sector shaft adjusting screw (43) counterclockwise into the side cover until the screw reaches solid height.

Rotate the adjusting screw clockwise one half turn so the side cover will rotate freely on the sector shaft.

*Trademark of Exxon Oil Corp.

Install jam nut

23. Install the sector shaft adjusting screw jam nut (47) onto the sector shaft adjusting screw (43) a few threads. Final adjustment will be made later.

Assemble vent plug

24. Press the new vent plug (49) into the hole provided in the side cover until the plug is bottomed.

⚠ WARNING **Do not weld or otherwise plug this hole in any permanent manner. This is a safety vent which functions only if the side cover seal fails. If the seal fails and the plug cannot vent, the steering gear may lock-up or otherwise malfunction.**

Install side cover gasket

25. Apply clean grease to the new side cover gasket (45) to hold it in place and assemble it onto the side cover (46).

Center rack piston

26. There are four teeth on the rack piston. Rotate input shaft to position the rack piston so the space between the second and third tooth is in the center of the sector shaft opening. This will center the rack piston for assembly of sector shaft.

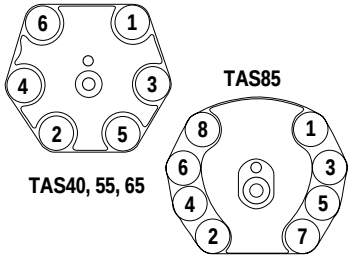
⚠ WARNING **If the rack piston is not centered when sector shaft is installed, gear travel will be severely limited in one direction. This could result in an accident.**

Install sector shaft and side cover into housing

Masking tape

27. Clean off any old tape on the serrations. Reapply one layer of masking tape. Install the sector shaft assembly into the housing. The center tooth of the sector shaft must engage the center space (between the second and third tooth) of the rack piston, with side cover gasket in place.

⚠ CAUTION **If the serrations are not properly taped, they will damage the output seal (38) in housing, causing the seal to leak.**



Install side cover bolts

13/16" Socket (TAS40) 15/16" Socket (TAS55, 65, 85) Lbf•ft Torque wrench

28. Install TAS40, 55 and 65 bolts in positions 3 and 4 first, by hand. For TAS85, Install in positions 3 and 6 first, by hand. Install the remaining special side cover bolts (48) into the side cover and torque them in the sequence shown. If bolts must be replaced, use bolts of the same design, type and length as those you removed. Do not use a substitute.

    Lubricate side cover bolts and torque TAS40 bolts to **118 lbf•ft** (160 N•m), TAS55, 65 and 85 bolts to **170 lbf•ft** (230 N•m).

Remove tape

29. **Standard gears** - Remove tape from sector shaft and pack the end of the housing trunnion area at the sector shaft with clean, high temperature industrial grease, Exxon Unirex* RS460. Apply more of the grease to the inside of the new trunnion dirt seal (39) and assemble it over the sector shaft and into the trunnion bore.

    Step bore gears - remove tape from the sector shaft.

Install dirt & water seal

Grease

30. Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease, Exxon Unirex* RS460. Apply more of the grease to the inside of a new dirt and water seal (2, 2B or 2C) and install it over the input shaft. Seat the seal in the groove behind the serrations and against the valve housing.

    This step may have already been completed if you disassembled the valve housing and worm screw for repair.

Proceed to Final Adjustments on page 63.

*Trademark of Exxon Oil Corp.

Poppet Component Replacement

Tools Required

2 lb Sledge
Lbf•ft Torque wrench
J36452-A
Press
⅜" x 6" drill rod
Ratchet
Soft-jawed vise

Materials Required

Locquic "T" primer
Loctite RC680

Place rack piston in vise

Soft-jawed vise

1. If the poppet assemblies are to be removed for replacement, place rack piston in a soft-jawed vise.

Loosen poppet adjuster seat

J36452-A
2 Lb Sledge

2. Slide special tool #J36452-A over the seat of poppet adjuster seat and sleeve assembly (22) and engage tool in the slots in the threaded sleeve. Hit the end of the tool firmly four or five times with a 2 lb sledge hammer to loosen Loctite.

⚠ CAUTION **Poppet adjuster seat and sleeve assemblies (22) are retained by Loctite applied to the threads which makes the assemblies difficult to remove.**

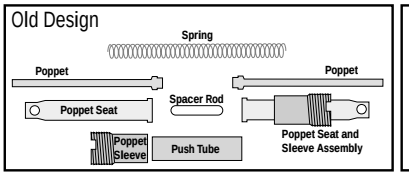
Remove poppet adjuster seat

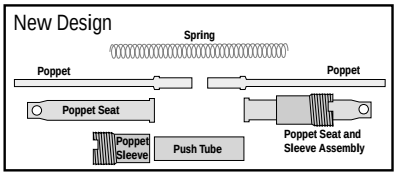
J36452-A

3. With a ratchet applied to the tool, turn one adjuster seat and sleeve assembly out of the rack piston. If the ratchet does not turn easily, strike the adjuster removal tool again with a hammer. If the engaging tangs won't stay in place while torquing, it might be necessary to hold in place with an arbor press while applying loosening torque. Discard poppet seat and sleeve assembly.

Remove poppet components

4. Remove the two poppets (23 or 23A), spring (24), and push tube (26). Some gears will also have a spacer rod (25) to be removed.





Remove other seat & sleeve if necessary

5. Remove and discard remaining poppet seat and sleeve assembly only if required.

NOTE It is possible to reset one poppet adjuster seat and sleeve assembly for automatic poppet adjustment while it is in the rack piston if one adjuster seat and sleeve assembly and the poppets, spring, spacer rod and push tube are removed.

Reset remaining poppet seat and sleeve assembly

Press
⅜" X 6" Drill rod

6. If one poppet seat and sleeve assy. (22) was left in rack piston, it can be reset for automatic poppet adjustment by inserting a ⅜" (9.52 mm) diameter X 6" (152.4 mm) drill rod down through the poppet seat hole at the opposite end of the rack piston and against the adjuster seat to press the seat in until it bottoms against the adjuster sleeve.

Apply Locquic "T" primer and Loctite RC680

Locquic "T" primer
Loctite RC680

7. Carefully apply Locquic "T" primer to the threads in poppet holes, and threads on the new seat and sleeve assemblies (22). Allow to dry for ten minutes; then carefully apply Loctite® RC680 to same threads.

⚠ CAUTION **Do not allow Loctite or Locquic to get on the adjuster seat component of the adjuster seat and sleeve assembly. The poppets will not function properly.**

Install one poppet seat and sleeve assembly

Soft-jawed vise

8. **⚠ WARNING** **Wear eye protection while assembling poppets, as spring loaded poppets could eject and cause eye injury.**

Place rack piston (19) in a soft-jawed vise and turn one new poppet adjuster seat and sleeve assembly (22), (slotted end out) into the poppet hole in one end of rack piston.

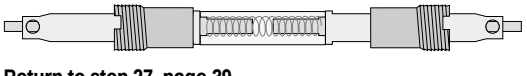
⚠ WARNING **Do not use the spacer with the new poppet design. You must install the spacer with the old poppet design.**

Install remaining poppet components

J36452-A
Lbf•ft Torque wrench

9. From the other end of the poppet hole in the rack piston, install: one poppet (23A), poppet spring (24), push tube (26), other poppet (23A), and the other new poppet adjuster seat and sleeve assembly (22). The new components will stack up as shown below.

Torque both poppet seat and sleeve assemblies to **18 lbf•ft** (25 N•m).



Return to step 27, page 39.

Valve Housing/Worm Screw Disassembly

Tools Required

Hammer
Lbf•ft Torque wrench
Punch, center
Punch, roll pin
Lbf•in. Torque wrench
J37464
J37070
J37073
Screwdriver
Small probe or pick
Sockets
12-point sockets

Materials Required

Place valve housing and valve assembly in vise

1. With worm vertical, place the valve housing, input shaft, valve/worm assembly in a vise.

Unstake adjuster locknut

Roll pin punch
Hammer

2. Unstake the valve housing (5) where it was upset into the adjuster locknut (18) slot. Also unstake adjuster nut from adjuster (17).

Remove bearing adjuster locknut

J37464

3. Turn bearing adjuster locknut (18) out of the valve housing.

Remove bearing adjuster

J37070

4. Turn bearing adjuster (17) out of the valve housing.

Remove seal ring and o-ring

Small probe or pick

5. Remove and discard seal ring (8) and o-ring (9) from bearing adjuster.

Remove input shaft

6. Remove the input shaft, valve/worm assembly (13 or 13A) from the valve housing.

Remove thin washer and bearing

7. Remove thin thrust washer (16) and thrust bearing (15) from input shaft.

Remove thick washer and bearing

8. Remove thick thrust washer (12) and thrust bearing (15) from valve housing.

⚠ CAUTION **Input shaft, valve worm assembly must not be disassembled further. The components were a select fit at assembly and are available only as part of this subassembly. If disassembled further, the subassembly must be replaced.**

OR

Remove bearing components

8A. For alternate construction TAS65 gears, remove spacer sleeve (14), thin washer (16), thrust bearing (15) and thick washer (12).

⚠ WARNING **If the TAS65 gear has a ball bearing and ball race in the valve housing, remove them and call TRW for disposition. Do not rebuild the gear.**

Remove seal rings and o-rings

Small probe or pick

9. Remove and discard seal rings (10) and (8) and o-rings (11) and (9) from valve housing (5).

Remove retaining ring

Screwdriver

10. Turn over valve housing and remove retaining ring (3).

Remove seal

1⅛" Socket Hammer

11. **⚠ CAUTION** **Exercise special care when removing seal (4) to prevent damaging the valve housing seal bore.**

Tap input shaft seal (4) out of valve housing. Discard seal.

NOTE The valve housing also utilizes a ball plug for manufacturing purposes that must not be removed.

Inspect input shaft, valve worm assembly sealing areas

12. Inspect the sealing areas of input shaft and valve (13 or 13A) for nicks and run your fingernail edge across the sealing surfaces to detect steps. Inspect for discoloration from excess heat. Inspect input shaft ball-track grooves for brinelling or spalling. If any of these conditions exist, you must replace the input shaft, valve/worm assembly, valve housing and balls. Also replace rack piston if brinelling or spalling is found.

Inspect thrust washers and bearings

13. Inspect the thrust bearing (15) rollers for any deterioration. Inspect thrust washers (12 & 16) for brinelling, spalling, or cracks. Replace any part with these conditions.

Alternate Construction TAS65: If spacer sleeve (14) is damaged, **replace the input shaft/valve/worm subassembly** and use thick washer and roller bearing only during reassembly.

Place valve housing in vise

14. Place valve housing (5) firmly in a vise so the input shaft, valve/worm assembly (13 or 13A) can be assembled vertically with the worm end up.

> **⚠ CAUTION** **Do not clamp against threaded port hole or relief valve hole sealing faces when placing valve housing in vise.**

Assemble o-ring

15. Oil and assemble a new o-ring (9) into its counterbore in valve housing.

Assemble other o-ring and seal ring

16. Lightly oil and assemble new o-ring (11) and new seal ring (10) into the large diameter seal ring groove in valve housing, bending and working them in and smoothing them out as necessary.

Install roller thrust bearing and washer

17. Install roller thrust bearing (15) and then the thick washer (12) (square side out) onto input shaft end of input shaft, valve, worm subassembly, seating them against the input shaft thrust face.

OR

Install bearing components

17A. **Alternate construction TAS65:** Assemble spacer sleeve (14) onto input shaft with radiused side toward valve. Make sure sleeve is square. Assemble thin washer (16), thrust bearing (15) and thick washer (12) onto input shaft behind spacer sleeve.

> **⚠ CAUTION** **If you are replacing the input shaft/valve/worm assembly, discard spacer sleeve and thin washer.**

Install seal ring

18. Lightly oil and assemble new seal ring (8) onto input shaft and against the thick thrust washer (12) to hold the bearing components in place.

Assemble input shaft, valve worm & bearing assembly

19. Dip the input end of the input shaft, valve, worm assembly (13 or 13A) into oil up to the worm lead. Assemble the input shaft end of the assembly into the valve housing (5) until it is firmly seated.

Assemble bearing and thrust washer

20. Apply oil and assemble the other thrust bearing (15) then the thin thrust washer (16) over the ball groove end of worm, and seat them against the shoulder of input shaft, valve, worm assembly.

Assemble seals in bearing adjuster

21. Lightly oil a new o-ring (9) and assemble into the seal groove in bearing adjuster (17). Oil and work a new seal ring (8) into the same groove and smooth it out.

NOTE Be sure the valve housing, adjuster locknut and bearing adjuster threads are clean and free of any staking burrs that would impede the locknut from turning freely on adjuster or the adjuster turning freely in valve housing.

Assemble bearing adjuster

J37070
Lbf•ft Torque wrench

22. Lightly oil and assemble bearing adjuster (17) over worm and into valve housing. Torque adjuster to **13 lbf•ft** (18N•m) indicated torque using a torque wrench inserted in adjuster tool #J37070. This will seat the components. Back off adjuster ¼ to ½ of a turn.

Assemble new locknut

J37464

23. Lightly oil and assemble new locknut (18) onto bearing adjuster (17) with radius (slightly rounded) side down. Tighten slightly to keep the bearing adjuster in place.

Adjust to required input torque

¾" or 11⁄16" 12-point socket
Lbf•in. Torque wrench

24. Reverse assembly in vise so the worm end is down. With an inch pound torque wrench on the input shaft, note torque required to rotate the input shaft 360° in each direction. Tighten the bearing adjuster to increase the maximum torque at the input shaft 5-10 lbf•in. (.5-1.0 N•m) over that which was previously noted.

Torque locknut

J37070
J37464
Lbf•ft Torque wrench

25. Again reverse the assembly in vise. Torque locknut while holding bearing adjuster in position established in step 24 with appropriate adjuster tool. When using a torque wrench in locknut tool J37464, the torque wrench reading should be **112 lbf•ft** (152 N•m).

NOTE The bearing adjuster, locknut and valve housing flange should be flush. If not, the seal ring (8) or o-ring (9) may be out of position; which will result in axial lash.

Check input shaft torque

26. Recheck input shaft torque. It should match torque measured in step 24. Repeat steps 24 and 25 if necessary.

Stake valve housing and locknut

Center punch
Hammer
13⁄16" Socket
Lbf•in. Torque wrench

27. Stake valve housing into the clockwise most corner of two opposing slots in locknut (18). Stake the locknut into the adjuster (17) in two places (180° apart) at threaded area. Choose areas that have not been previously staked.

After staking, torque required to rotate input shaft must be between **5-10 lbf•in.** (.5-1.0 N•m) **greater** than the torque noted in step 24. Torque value must **not exceed 22 lbf•in.** (2.5 N•m). Unstake and readjust if necessary.

Reposition subassembly in vise

28. Reposition worm screw/valve housing subassembly in soft-jawed vise, clamping tightly against valve housing, so the worm screw is pointing down.

Install input shaft seal

J37073
Hammer

29. Apply clean grease (Exxon Unirex* RS460) to the outside and inside diameters (fill cavity between the lips) of the new input shaft seal (4) and assemble it, garter spring side first over the input shaft. Align seal in the valve housing seal bore.

Assemble seal installer tool #J37073, small diameter end first, over the input shaft and against the seal. Tap the seal installer tool until the tool shoulder is squarely against the valve housing. This will correctly position the seal in the housing bore just beyond the retaining ring groove.

Remove any seal material that may have sheared off and is in seal bore and retaining ring groove.

⚠ CAUTION **The input shaft seal must be square in the seal bore and installed to the correct depth.**

Insert retaining ring

30. Insert new retaining ring (3) into its groove in valve housing.

Install dirt & water seal

Grease

31. Pack the end of the valve housing bore around the input shaft with clean, high temperature industrial grease, Exxon Unirex* RS460. Apply more of the grease to the inside of a new dirt and water seal (2, 2B or 2C) and install it over the input shaft. Seat the seal in the groove behind the serrations and against the valve housing.

Return to step 28, page 40.

*Trademark of Exxon Oil Corp.

Roller Bearing or Ret. Ring Repl. - Standard

Tools Required		Materials Required
Press J37071 (TAS55, 65) or J37071-A (TAS55, 65) J37705 (TAS40) J38779 (TAS85)	Screwdriver	

Remove roller bearing if required

J37705
J37071
or J37071-A
J38779
Press

1. **Standard Gears Only:** If roller bearing (37) in housing needs to be replaced, place the bearing removal end (long end) of the bearing and seal tool against the side cover end of the bearing and press it out of trunnion end of the bearing bore. Discard bearing.

Remove retaining ring

Screwdriver

2. **Standard Gears Only:** If the retaining ring (36) that is still in the housing bearing bore needs to be replaced, remove it through the trunnion end of the bearing bore to protect the pressure seal bore area from being damaged.

Install retaining ring

Grease

3. **Standard Gears Only:** Insert retaining ring (36), if it was removed, into the housing bore from the trunnion end (to protect sealing area). Make sure it is seated in the retaining ring groove closest to side cover end of the bearing bore. Lubricate the bearing bore.

Press in housing roller bearing

J37705
J37071 or
J37071-A
J38779
Press

4. **Standard Gears Only:** Press the roller bearing (37) into the housing from the trunnion end of bearing bore until it is seated against the retaining ring. **Don't push it farther.** Be sure the housing is square with the press base and the bearing is not cocked.

⚠ CAUTION **Use the bearing installation end of the tool (short end). If the bearing removal end of the bearing & seal tool is used to press in bearing, the cage on the new bearing may be damaged.**

Return to step 32, page 40.

Roller Bearing Replacement - Step Bore

Tools Required	Materials Required
Press J37071-A (TAS65 Step Bore gear)	

Remove roller bearing if required

J37071-A
Press

1. If roller bearing (37) in housing needs to be replaced, place the bearing removal end (long end) of the bearing and seal tool against the trunnion end of the bearing and press it out of the side cover end of the bearing bore. Discard bearing.

Press in housing roller bearing

J37071-A
Press

2. Press the roller bearing (37) into the housing from the side cover end of the bearing bore until it is seated against the step bore. Be sure the housing is square with the press base and the bearing is not cocked.

⚠ CAUTION **Use the bearing <u>installation end</u> of the tool (short end). If the bearing <u>removal end</u> of the bearing & seal tool is used to press in bearing, the cage on the new bearing may be damaged.**

NOTE If the unmachined trunnion face is not square, use shims to square it before pressing in the bearing.

Return to step 32, page 40.

Replace Housing Ports, Plugs, Screws, Fittings

Tools Required	Materials Required
Allen wrench Torx sockets Sockets Lbf•in. Torque wrench Lbf•ft Torque wrench	

Replace poppet fixed stop screw

5/8" Socket or E-14 Torx socket
lbf•ft Torque wrench

1. If damaged, remove and replace the poppet fixed stop screw (52 or 52A) and washer (53) if equipped. Replace with poppet fixed stop screw (52A), discard the washer. Torque to **48 lbf•ft** (65 N•m).

Replace poppet adjusting screw

7/32" Allen wrench
3/4" or 5/8" closed-end wrench
Lbf•ft Torque wrench

2. If damaged, remove poppet adjusting screw (59) and sealing nut (60) without allowing the nut to change its position on the screw.

   Assemble the new nut onto the new adjusting screw, matching its position to the nut and screw removed. Torque sealing nut to **35 lbf•ft** (47 N•m).

Replace automatic bleed screw, and aux. port plugs

E-14 Torx socket
Lbf•ft Torque wrench

3. If damaged, remove and replace automatic bleed plug (51). Torque to **48 lbf•ft** (65 N•m).

   If damaged, remove and replace permanent auxiliary port plugs (54) and o-rings (55). Assemble new o-rings (55) on port plugs and torque to their respective ports in the housing or valve housing to **30 lbf•ft** (41 N•m).

Replace manual bleed screw

5/16" Hex socket
Lbf•in. Torque wrench

4. If damaged, remove and replace manual bleed screw (50). Torque to **45 lbf•in.** (3.4 N•m).

Return to inspection section, page 41.

Final Adjustments

Tools Required

Box-end wrench
Lbf•ft Torque wrench
Lbf•in. Torque wrench
Screwdriver
Sockets

Materials Required

Center steering gear

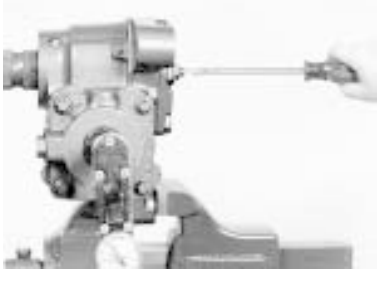
¾" and 11⁄16" Socket or box end wrench

1. To center the steering gear, rotate input shaft, valve worm assembly (13 or 13A) until the timing mark on the end of the sector shaft (42) is in line with the timing mark on the end of housing trunnion.

⚠ CAUTION **Do not rotate the input shaft more than 1.5 revolutions from center position until the steering gear is installed, during poppet setting procedure. Doing so could make the automatic poppets inoperative, which would require disassembly of steering gear to reposition poppet seat and sleeve assemblies.**

NOTE Initial poppet contact will occur at less than one input shaft rotation in one direction from steering gear center position, if new or reset poppet adjuster seat and sleeve assemblies are assembled in the unit.

NOTE Worm preload adjustment was set when input shaft, valve and worm were assembled into valve housing.

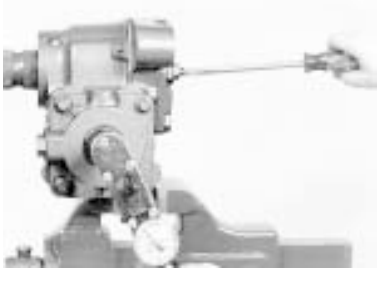


Tighten adjusting screw

Lbf•in. Torque wrench
Screwdriver
11⁄16" or ¾" Socket

2 With adjusting screw jam nut (47) loose, turn sector shaft adjusting screw (43) clockwise to provide 45-50 lbf•in. (5-5.5 N•m) of torque required to rotate the input shaft, valve/worm assembly (13 or 13A) through one half turn (180°) each side of center.

NOTE This procedure will properly mesh and seat the rack piston and sector shaft teeth for final adjustments.



Loosen adjusting screw and note torque

Lbf•in. Torque wrench
Screwdriver
11⁄16" Socket

3. Turn sector shaft adjusting screw (43) counterclockwise one half turn and **note maximum torque** required to rotate the input shaft, valve/worm assembly through one half turn (180°) each side of center.

Adjust adjusting screw

- ¾" Socket
- 11/16" Socket
- Lbf•ft Torque wrench
- Lbf•in. Torque wrench

4. Adjust sector shaft adjusting screw (43) clockwise **to increase** maximum torque noted in step 3 by **7 lbf•in.** (.8 N•m). Tighten jam nut (47) firmly against side cover while holding the adjusting screw in position. **Final torque jam nut to 43 lbf•ft** (58 N•m) and check input shaft, valve/worm assembly torque again. Readjust if input shaft torque exceeds 40 lbf•in. (4.5 N•m).

Section 5 Reinstallation

Reinstallation 65
Poppet Resetting 65
Glossary 66

Reinstallation

- Verify that axle stops are set to manufacturer's wheelcut or clearance specifications.
- Bolt gear to frame, torque to vehicle manufacturer's recommendation.
- Connect return line to reservoir in TAS return port.
- Connect hydraulic line from pump to pressure port in TAS unit.
- Connect steering column to input shaft, torque pinch bolt to vehicle manufacturer's recommendation.
- Install pitman arm on output shaft, with timing marks aligned. Torque bolt to vehicle manufacturer's recommendation.
- Connect drag link to pitman arm.

Poppet Resetting

IF Poppets remain unchanged from when gear was removed from vehicle, and gear is being installed on the same vehicle with no change in axle stops or linkage.	After installation, check to make sure poppets relieve in both turns just before axle stop contact is made. If not, use resetting procedure beginning on page 24.
IF Poppets were replaced with new components or reset during gear disassembly, and are ready for automatic positioning.	Use poppet setting procedure on page 15.
IF Poppets may have been moved during disassembly or reassembly procedures, or gear is being installed on a different vehicle.	Use poppet resetting procedure beginning on page 24.

Glossary

Aerated Fluid
Fluid with air bubbles

Automatic Bleed Systems
Gears are mounted in such a way that trapped air can be forced out of the system "automatically" without loosening bleed screw. Follow procedure on page 13.

Axial
In-out movement along an axis (imaginary straight line on which an object moves)

Brinelling
Dents

Date Code
Date the steering gear was built (Julian date)

Discoloration
Change in color

External Leakage
Fluid Leaking out of the system or steering gear

Full Turn
Hub contacts axle stop

Integral Power Steering
Steering gear has manual steering mechanism, hydraulic control valve, and hydraulic power cylinder all within gear housing.

Impact
The application of torques and forces to steering gear components during accidents or other similar events which exceed the hydraulic capacity of the steering gear

Internal Leakage
Fluid leaking inside the gear

Lash
Free play

Manual Bleed Systems
Gears are mounted in such a way that an air pocket could form in one end of the steering gear. The bleed screw is positioned so trapped air can be forced out when loosened. Follow procedure on page 13.

OSHA
Occupational Safety and Health Administration

Poppets
Unloading valves, reduce pressure in full turns.

Relief Valve
Limits maximum supply pressure

Return Line
Line that connects steering gear to reservoir to recirculate hydraulic fluid

Rotary Control Valve
Controls flow in internal cavities

Scoring
Scratch

Shock Load
Shake or jar

Spalling
Flaking or chipping

Subassembly
An assembled unit that fits into a larger unit

Supply Line
Line that connects pump to steering gear

Twisted Serrations
Output shaft serrations damaged by impact overload. Serrations can be twisted at the area between the large diameter of the shaft and the end of the serrations.

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TRW1108 Rev. 3/06